Analysis of Survival Times for Ducks Based on Individual Time Intervals

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Contents

1. Introduction

This report describes analyses carried out as part of a study on the survival of a number of species of wild duck that are native to Western Australia. The analyses were performed to assess the importance of specific factors which are thought to influence the lifetime distribution of ducks banded over the 25 year period from 1952 to 1976 in the WA Wildlife Research Centre Duck Banding programme. The analyses discussed in this report refer to three species of ducks: Black Duck, Grey Teal, and Mountain Duck, although other species were involved in the study.

Originally, data records were available on 33168 ducks, of which 5947 had at least one recapture between 1953 and 1985. However, some data were for species other than those three of interest and were excluded from the analyses. The total number of ducks on which these analyses are based is 32431. Variables of interest for these analyses included sex, species, and the state where they were recovered. For a comprehensive summary of these variables, see the report by D A Diepeveen and I R James entitled "Duck Banding Programme - Interim Report: Data File Preparation and Summary" (Statistical Consulting Group, July 1987). The data used for the analyses are discussed further in Section 2.

For each duck, only a categorical estimate of age: duckling, juvenile, sub-adult (only in the case of Mountain ducks), and adult was made at initial banding. If the duck was later recovered (dead), a precise time of death was recorded. Hence, the survival data is complex, as the survival time for any duck is only known to lie in one of the intervals shown below:

Duck banded as	Time interval for category	Estimated survival time lies in the interval
Duckling	0 - 59 days	T to T + 59 days
Juvenile	60 - 365 days	T + 60 to T + 365 days
(Mountain duck:	60 - 239 days	T + 60 to T + 239 days
Sub-Adult	240 - 365 days	T + 240 to T + 365 days)
Adult	> 365 days	T + 366 days to ∞

Table 1: Banding intervals.

In Table 1 T is the time, in days, between first banding and recovery of the duck.

A parametric approach to modelling the data was adopted. Rather than use methods based on multinomial models (Brownie et al, 1978), models of the Jolly-Seber type (Brownie and Robson, 1983), purely non-parametric estimation methods (Turnbull, 1976) or semi-parametric methods (Finkelstein and Wolfe, 1985 and Finkelstein, 1986), a method based on Cox's *proportional hazards* model (Cox, 1972) was used. This enabled the effect of different factors to be estimated as parameter values. Turnbull's non-parametric method for estimating survival curves (Turnbull, 1976) was used to determine which survival distribution to use. The statistical models and methods used for the analyses are discussed in Section 3. The use of Cox's proportional hazards model in the way described in Section 3, as far one knows, is new.

The results of the analyses are presented and discussed in Section 4, and Section 5 is a short summary on how the numerical results can be used.

2. Data

2.1 Data Screening.

The data used in these analyses were screened, as far as possible, prior to the analyses, so the problems encountered during the analyses relate entirely to incomplete data records. In particular, 10116 ducks did not have a sex classification. However, most of these occurred in a group excluded from the analyses because the observed time provided no information in the sense that the estimated interval was from 0 to ∞ (see below).

Each analysis was conducted using as many observations (see Section 2.2) as possible: if a factor was at any stage determined to have little influence (in a statistical sense; see Sections 4.2 and 4.3) on the survival probability, the observations which were excluded from the analyses on the basis of missing values for that factor were re-incorporated.

It is worth noting that there are relatively very few (369) observations with a known upper bound for the lifetime interval, on which to base these analyses. These observations we will call *uncensored*. Also, there are a substantial number of observations which provided no information at all (those with 0 lower bound and infinite upper bound), and these observations can be omitted from the analyses. For each species, the number of uncensored and *censored* observations (those with unknown upper bounds), plus numbers of observations contributing no information are given in the table below.

	Black Duck	Grey Teal	Mountain Duck	Total
No info.	9155	1938	365	11458
Uncensored	138	228	3	369
Censored	16843	3473	288	20604

Table 2: Species by censoring type.

There is the added complication that the age when a duck is first banded will certainly affect its contribution to the overall lifetime. That is, the data for ducks first banded at an early age will result in a higher estimated mortality than that for ducks first banded as adults, which have unbounded time intervals. Thus by ignoring the initial banding category, any results will be affected excessively by the adult ducks, which are the largest group by far. The effect will be to increase the probability of survival, or decrease the mortality rate, for any given time.

In order to get a more realistic assessment of survival rates, the analyses should therefore be carried out for each initial banding category. This in turn poses other problems: the chosen method of analysis (see Section 3) will only work if a group has at least one observation with a finite upper bound, and this is not the case for ducks first banded as adults, nor for those first banded as sub-adults. Secondly, there are very few ducks first banded as ducklings (the table below gives a breakdown of species by age at first banding). This is unfortunate because it is this group that would provide the best information on a duck over its complete

lifetime, the other age groups being biased by conditioning on having reached a certain age. However, there are reasonable numbers of juveniles, and the results for this group are probably the most relevant to estimation of lifetime probabilities from this study. The following table gives the breakdown of the number of observations for each initial banding category by species.

	Species			
Age Category	Black Duck	Grey Teal	Mountain Duck	Total
Duckling	5	26	0	31
Juvenile	4820	1687	109	6616
Sub-adult	-	-	12	12
Adult	11340	1635	133	13108
	16165	3348	254	19767

Table 3: Age category at first banding by species.

Because of the general problem of low numbers, an additional set of analyses were carried out grouping ducks from all the banding categories together. That is, ignoring age category at initial banding. The results for these analyses are presented in Appendix B, but, for the foregoing reasons, too much importance should not be placed upon them, as they grossly over-estimate the mean lifetime.

2.2 Variables and factors used in the analyses.

As mentioned in Section 1, the purpose of the analyses was to assess the influence of certain factors on the lifetime (or *survival*) distribution of ducks. As discussed, a duck's age at the time of recovery was only known to lie in a specific time interval. Further, if the duck was not recovered, so that its fate at the end of the programme (1985) was unknown, only a lower bound for this interval could be calculated. This was the case for the great majority of the ducks banded in the programme. The factors of interest were the sex (hereafter denoted by SEX), species (SPECIES), State of recovery (STATE), and the age category at first banding. However, because the analyses were carried out for each age category, the last factor was excluded. The factors included in the analyses represent the following information:

SEX - male or female;

SPECIES - Black Duck, Grey Teal, or Mountain Duck;

STATE - New South Wales, Victoria, South Australia, Western Australia, or Northern Territory (there were no recoveries in Queensland, and one from Tasmania was in the 0 - ∞ group.).

For each duck, a data record consisted of the lower and upper bounds for lifetimes, plus relevant information about these factors. The only factor with missing data was SEX, as mentioned in Section 2.1. This may have affected the results (but probably not the conclusions), as SEX was found to be a significant factor contributing to survival probabilities (see Section 4.4). Tables 4(a) to 4(c) provide further information on the breakdown of the data. In both cases the observations with 0 lower bound and infinite upper bound have been omitted, so that the numbers in the tables are the numbers actually used in the analyses.

	Species			
State	Black Duck	Grey Teal	Mountain Duck	Total
NSW	-	4	-	4
Victoria	-	17	-	17
SA	-	1	-	1
WA	16981	3678	291	20950
NT	-	1	-	1
Total	16891	3701	291	20973

Table 4(a): SPECIES by STATE.

	Banding category				
State	Duckling	Juvenile	Sub-adult	Adult	Total
NSW	-	4	-		4
Victoria	-	1	-		1
WA	34	6615	12	13111	19772
Total	34	6619	12	13111	19777

Table 4(b): STATE by initial banding category.

	Sex			
Age Category	Male	Female	Unknown	Total
Duckling	14	17	3	34
Juvenile	3487	3129	3	6619
Sub-adult	7	5	0	12
Adult	7466	5642	3	13111

Table 4(c): Initial banding category by SEX.

3. Statistical methods

The statistical models used in the analyses were chosen after careful consideration of the type of data. With exact lifetimes, the aims of these analyses can be achieved by straightforward *survival analysis* techniques. However, the nature of the data in this study is more complex: the usual form of data used for a survival analysis would be a lifetime for recovered ducks (an uncensored observation), or a minimum bound of this lifetime, for ducks alive at last sighting (a censored observation). This is not the case for the data described above, and hence the following approach was adopted.

It is certain that the lifetime t of a duck lies in some interval between a lower and an upper bound, l and u say (for unbounded intervals $u = \infty$). If T is a random variable (rv) which denotes the lifetime of the duck, then the aim of these analyses is to establish a reasonable model for the distribution of T, F_T , where $F_T(t) = \mathbb{P}(T \leq t)$, which takes into account the effect of the different groups discussed in Section 2.2. As is more usual, the model is discussed in terms of the *survival function* S_T, where $S_T(t) = 1 - F_T(t)$.

A general approach to modelling such a function in the situation where there are different groups, each distinguished by a set of possibly different covariates, was developed by Cox (1972). The resulting model is known as the proportional hazards model. If we

let $\underset{\sim}{x}$ denote the vector of covariates describing the characteristics, e.g. species, sex, recovery State, and so on, of a duck from a certain group, then the proportional hazards model for S_T has the form $S_T(t \mid \underset{\sim}{x}) = S_0(t)^{\exp(h)}$, where S_0 is a survival function independent of the covariates, and $h = \underset{\sim}{\beta}'\underset{\sim}{x}$ is a linear combination of the covariates. $\underset{\sim}{\beta}$ is a vector of (unknown) parameters, and the survival function S_0 will also depend on a set of parameters, $\underset{\sim}{\theta}$ say. It is the values of the parameters in $\underset{\sim}{\beta}$ that represent the effect of the different groups, and hence these must be estimated. The values of $\underset{\sim}{\theta}$ are also of interest, and so these are also estimated.

The method of *maximum likelihood estimation* can be used to obtain estimates for $\underset{\sim}{\beta}$ and $\underset{\sim}{\theta}$. Now, by definition, the "likelihood" of any particular value of T is proportional to the probability that the value is observed (for a discrete rv the likelihood is this probability), so, for the range of values in the interval from l to u, the likelihood given $\underset{\sim}{\beta}$ and $\underset{\sim}{\theta}$ is proportional to $\mathbb{P}(\, l < T \leq u \mid \underset{\sim}{\beta},\underset{\sim}{\theta})$. This method of estimating parameters for interval-censored data has been used previously: see, for example, Swan (1969), who models similarly censored data from a Normal distribution.

We can write $\mathbb{P}(\, l < T \leq u \mid \underset{\sim}{\beta},\underset{\sim}{\theta})$ as $S_T(l|\underset{\sim}{\beta}) - S_T(u|\underset{\sim}{\beta})$, so that $\underset{\sim}{\beta}$ can be estimated from the following function,

$$\begin{aligned} L(\underset{\sim}{\beta},\underset{\sim}{\theta}) &= \prod_i \{\, S_T(l_i|\underset{\sim}{\beta}) - S_T(u_i|\underset{\sim}{\beta}) \,\} \\ &= \prod_i \{\, S_0(l_i)^{\exp(h)} - S_0(u_i)^{\exp(h)} \}, \end{aligned} \qquad (1)$$

that is, the product of the individual (denoted by i) probabilities over all the observed intervals, which is proportional to the likelihood for all the observations. Hence maximization of (1) is equivalent, as far as parameter estimation is concerned, to maximization of the likelihood function. As is customary, the function actually used for the estimation was the (natural) logarithm of (1). That is,

$$\ell(\underset{\sim}{\beta},\underset{\sim}{\theta}) = \sum_i \log \{\, S_0(l_i)^{\exp(h)} - S_0(u_i)^{\exp(h)} \} \qquad (2)$$

was maximized.

However, in order to ensure the validity of results, care must be taken in the choice of the survival function S_0. In order to make a reasonable choice, it was necessary to investigate the possible shape of S_0. This was done by using the method of Turnbull (1976) (see Finkelstein, 1986 for a more readable explanation of this method) which uses maximum likelihood to obtain a non-parametric estimate of the distribution function F (= 1 - S) in the case where observations are interval censored (his method is in fact more general). From the estimated survival function, an estimate of the *hazard function* of the distribution was obtained. The hazard function, $\lambda(t)$ say, is the *instantaneous failure*, or mortality, rate. It is usual to judge which lifetime distribution is appropriate from the shape of this function (or, more precisely, its logarithm - the *log-hazard function*: see Cox and Oakes, page 25, for a table of various choices based on $\lambda(t)$). Results of this preliminary analysis indicated, at least for the two larger groups (Black ducks and Grey Teals), that an *extreme value* or possibly *Weibull* lifetime distribution was appropriate. The Weibull distribution was suggested by the non-linearity of the log-hazard function plot for the Black ducks, clearly the largest and hence statistically the most influential group.

4. Estimation Procedure and Results

4.1 Non-parametric estimation of survival curves

The first stage of the analyses involved obtaining the maximum likelihood estimate for the non-parametric survival curve of each group using Turnbull's method. This was done for each of the species. Figure 1 is a plot showing the estimated survival curves for the three species of interest. The respective hazard function plots are shown in Figure 2. Note that there is a sudden increase in the hazard rate at about 8 to 10 months. This coincides with the period just after the nominal age group changes from juvenile to adult in Black ducks, juvenile to sub-adult in Mountain ducks. The same feature is not present for the Grey Teal group. Perhaps this phenomenom requires further investigation.

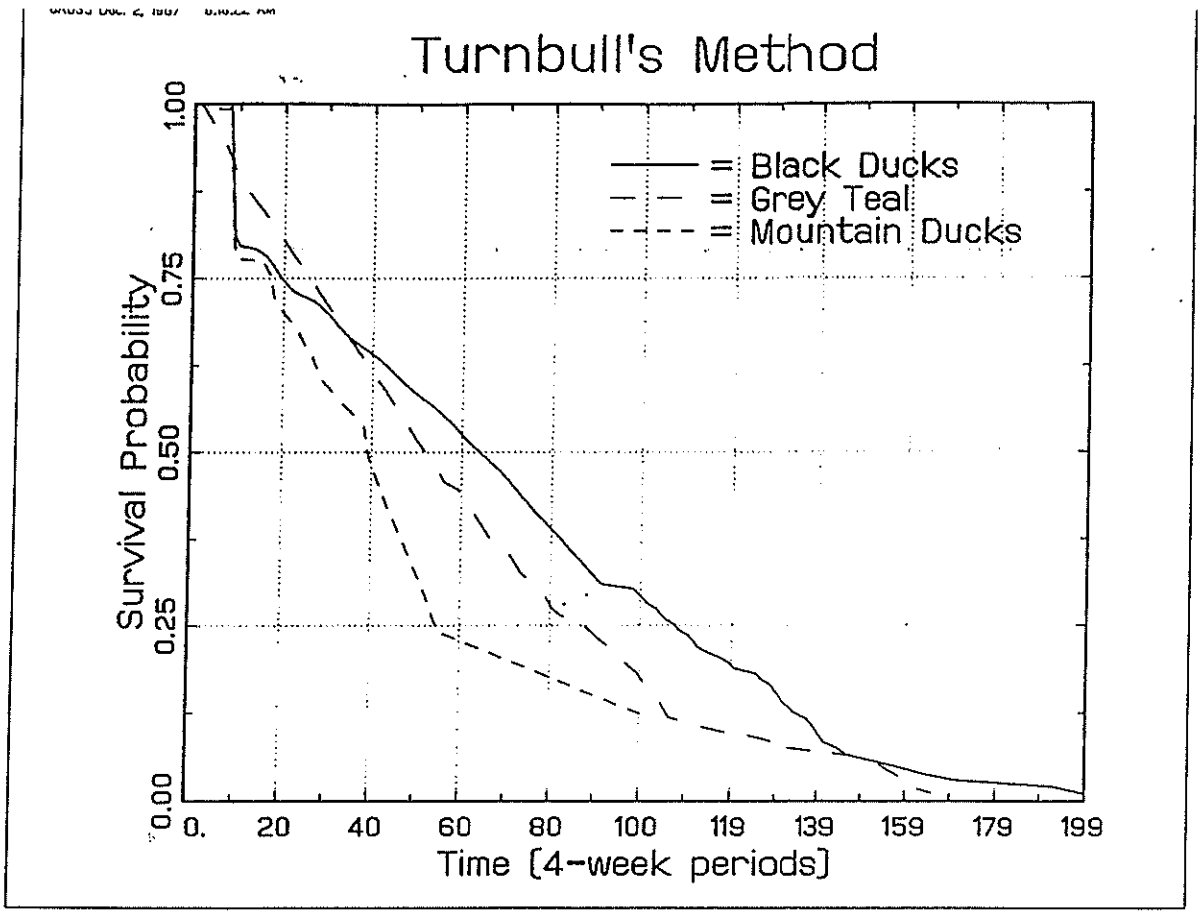

Figure 1

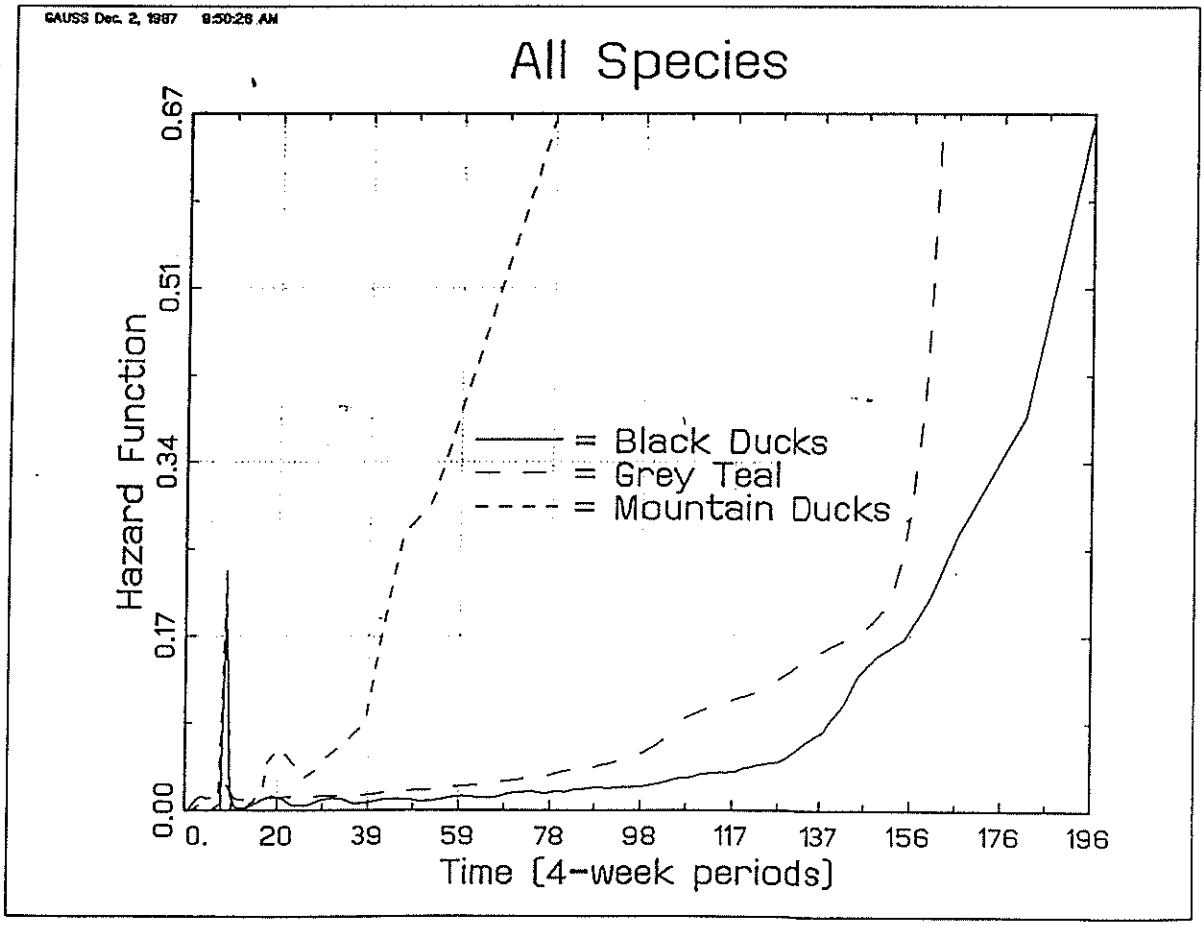

Figure 2

Although the analyses were carried out by age category, it was considered necessary to do this preliminary analysis by species in order to use the information from ducks banded as adults.

4.2 Parametric model fitting

Plots of the logarithm of the individual hazard functions (Figures 3-6 below) were used to determine appropriate models for the underlying survival function. Note that the log-hazard function plot is smoothest for the Grey Teal group, followed by the Black Ducks group. These are the two largest groups and hence would tend to dominate, in a statistical sense, the modelling process. All plots suffer from excess variability at the lower end of the time scale, particularly around the time corresponding to the "spike" in the hazard function discussed in Section 4.1. The decision of which survival distributions to model were based on the plot of the logarithm of the hazard function for Black Ducks and Grey Teal, ignoring the effect of this variability, which is confined to a relatively small interval of time. For these two groups the plots suggest a Weibull survival distribution (nonlinear log-hazard function - see below), or, if the perceived nonlinearity in the plots is artefact, an extreme value distribution. The results suggest that the former is more suitable, although a formal investigation of the difference between the distributions was not conducted.

The log-hazard plots can be used to obtain initial estimates for the shape and location parameters, $\underset{\sim}{\theta}$, of S_0. For a Weibull distribution,

$$S_0(t) = \exp[-t^{\theta} \times \exp(\beta_0)]$$

(parametrized in this way to enable natural extension to the proportional hazards model), and

$$\lambda(t) = \exp(\beta_0) \times \theta \times t^{\theta-1}.$$

The log-hazard is thus

$$\ell(t) = \log \theta + \beta_0 + (\theta - 1) \times \log t,$$

and hence from a plot of $\ell(t)$ against $\log t$ (not included),

$$\hat{\theta} = \text{estimated slope of the line} + 1,$$

$$\hat{\beta}_0 = \text{estimated intercept of the line} - \log \hat{\theta}.$$

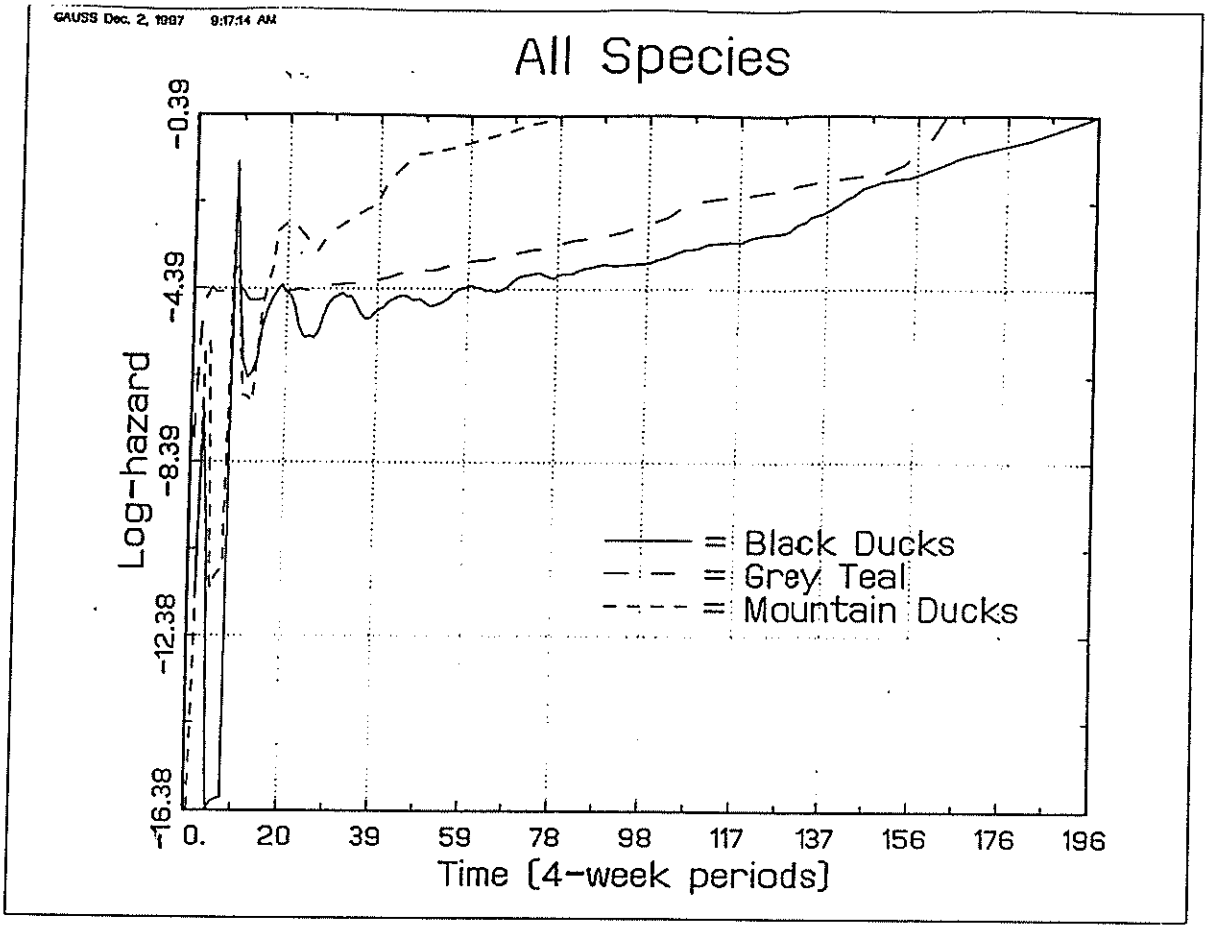

Figure 3

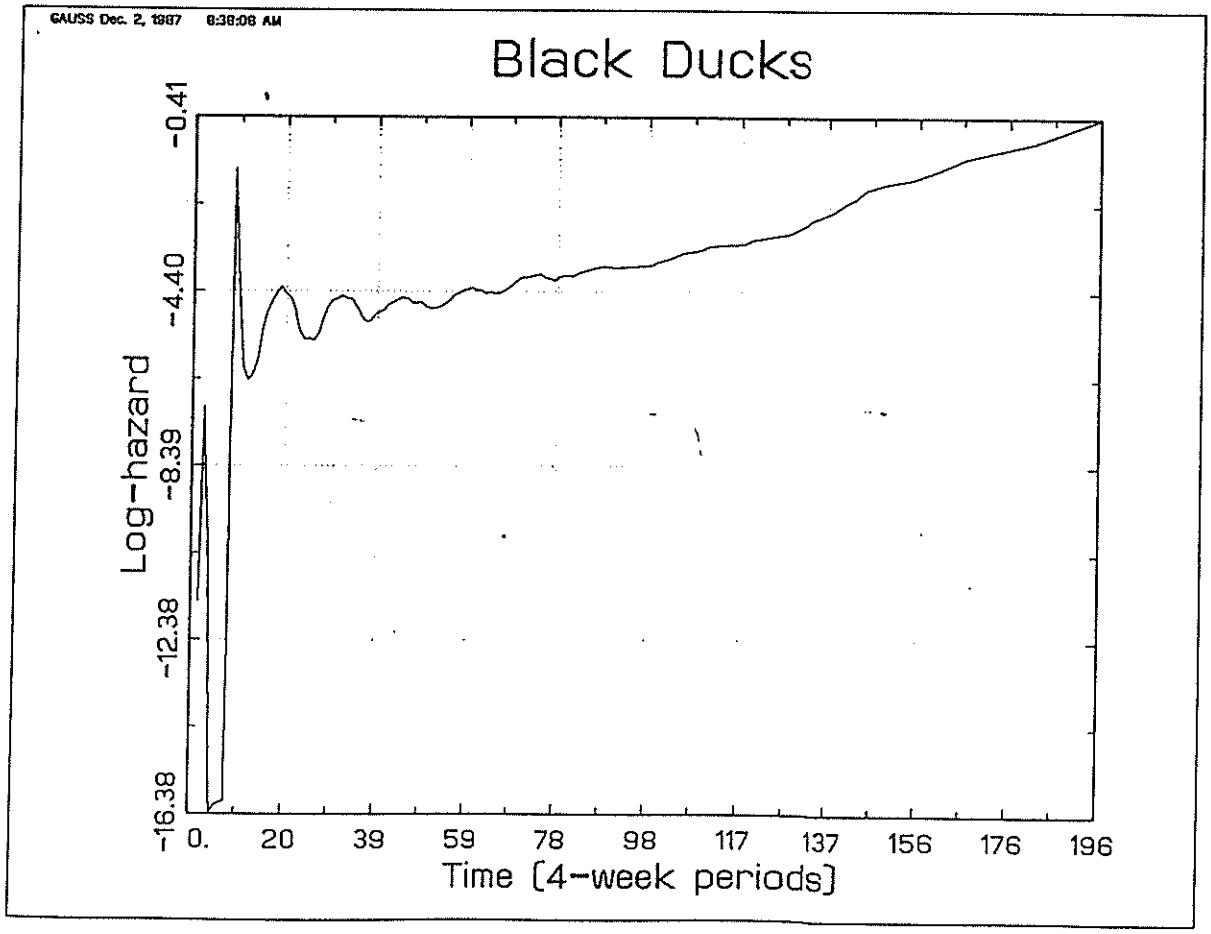

Figure 4

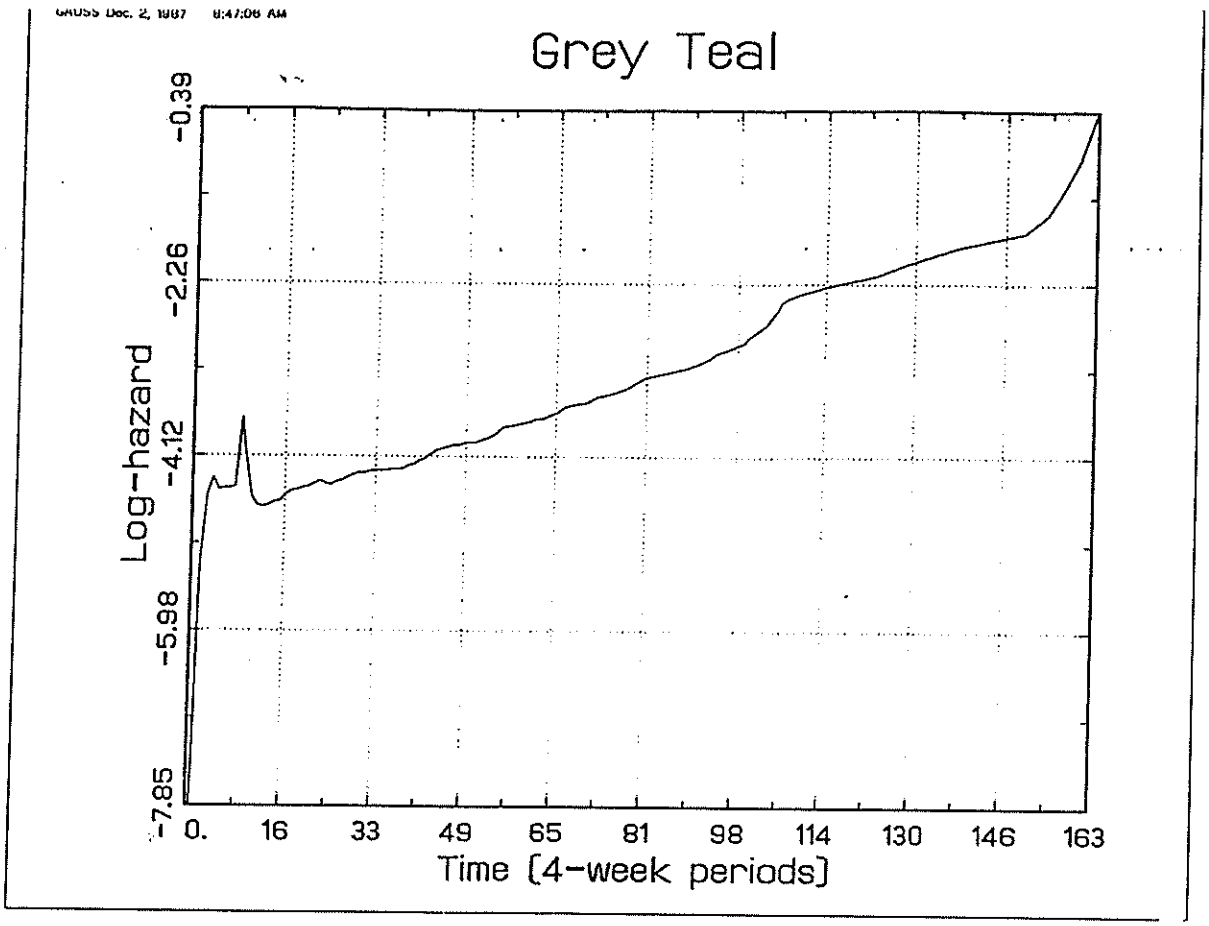

Figure 5

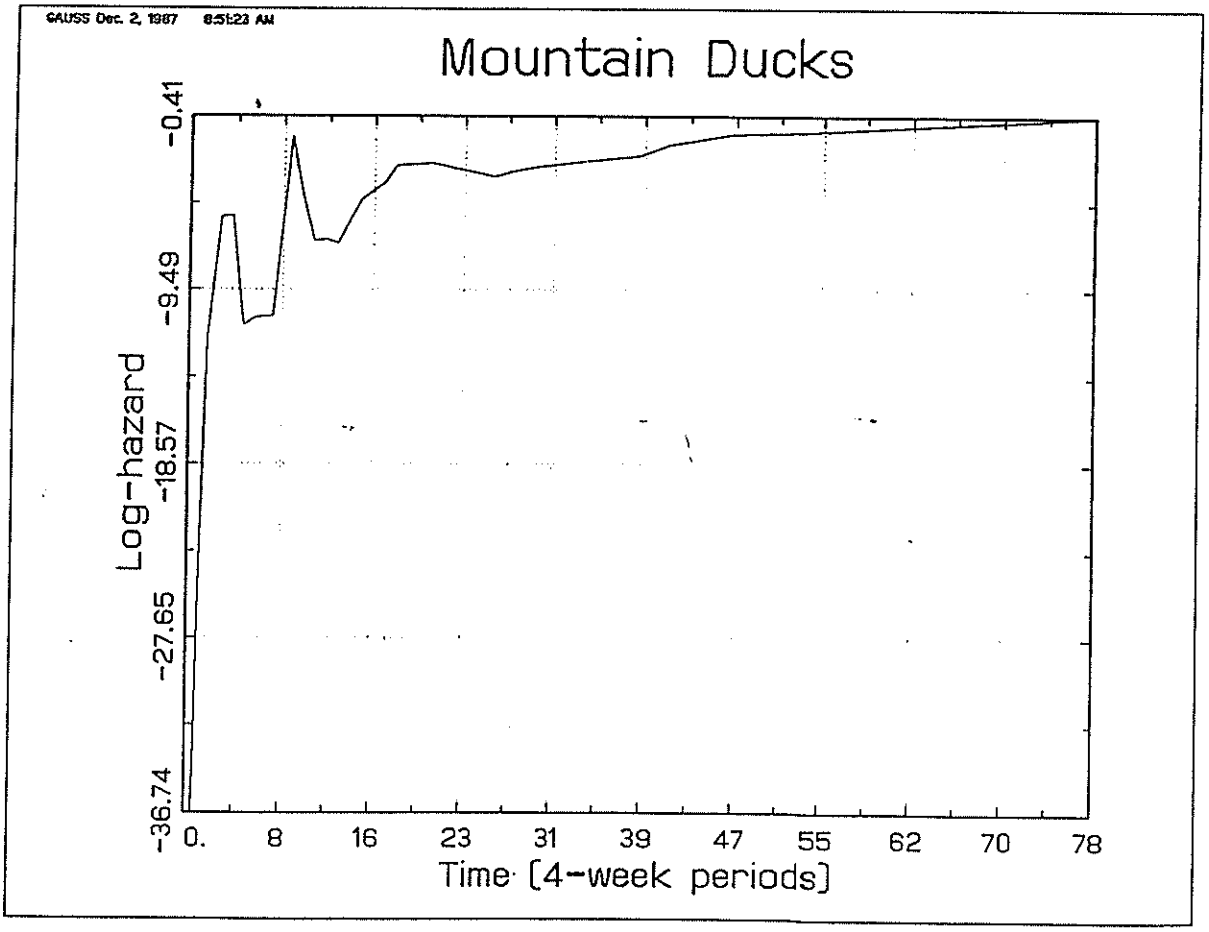

Figure 6

Here "^" denotes an estimate. Note that the parametrization is arbitrary, but should be chosen so that the parameters are not strongly correlated. We could have incorporated β_0 into $\underset{\sim}{\theta}$, for example.

Similarly, for the extreme-value distribution,

$$S_0(t) = \exp[-(\exp(\theta t) - 1) \times \exp(\beta_0)\ ],$$

$$\lambda(t) = \theta \times \exp(\beta_0) \times \exp(\theta t),$$

and $$\ell(t) = \log \theta + \beta_0 + \theta \times t,$$

so that

$\hat{\theta}$ = estimated slope of the line,

$\hat{\beta}_0$ = estimated intercept of the line - $\log \hat{\theta}$.

The initial estimates obtained were:

	Distribution of S_0	
Estimate	Ex. Value	Weibull
$\hat{\theta}$	0.002	1.6
$\hat{\beta}_0$	1.215	-7.97

Table 5: Initial parameter estimates.

These estimates were used to initiate the fitting process for the analyses to assess the influence of the factors discussed in Section 3. A number of models were fitted, and variables were included and deleted from these on the basis of the statistical significance of the estimates. The final (i.e. the most parsimonious) model was deemed as obtained when variables could no longer be excluded from the model on the basis of their lack of significance. That is, when all remaining parameter estimates were significantly different from 0. This type of model fitting is known as *backward elimination*. The actual test for significance is based on the usual assumption that the parameter estimates are asymptotically Normally distributed about the true paramater values.

As is usual in this type of estimation, there is a constraint that for any factor with k levels, only k - 1 parameters are estimable. To satisfy this constraint, the convention of setting the first level of each factor to 0 was adopted. This means that the effect of other factor levels represent deviations from the first level.

4.3 Results.

The following are the final parameter estimates for some of the models fitted. The names of the variables correspond to factor levels, with θ denoted by "Time" and β_0 by "Constant". Where an estimate is marked "not significant", this has been determined on the basis of the statistic

$$z = \frac{\text{Estimate}}{\text{Std Error}}$$

where z, as discussed above, is assumed to be Normally distributed.

(I) Group first banded as ducklings.

Here there are so few parameters involved that including the covariance matrix for the parameter estimates immediately after the estimates will not detract from the clarity of the results.

(a) Weibull models: $S(t) = \exp[-t^{\theta} \times \exp(\underset{\sim}{\beta}'\underset{\sim}{x})]$.

(i) Single group

Parameter values:

Variable	Parameter	Std. Error
Constant	-7.089974	1.151071
Time	1.478515	0.225272

Covariance matrix of parameter estimates

1.324965	
-0.253310	0.050748

(ii) Different species and sex.

Parameter values:

Variable	Parameter	Std. Error
Constant:	-23.306255	6.143128
Species: Grey Teal	6.212223	1.906203
Sex: Female	0.586734	0.664637 *
Time:	3.769623	0.977342

* not significantly different from 0 at 5% level.

Covariance matrix of parameter estimates

37.738024			
-10.630337	3.633608		
-1.281607	0.392484	0.441742	
-5.889799	1.534536	0.139524	0.955198

(iii) Different species (Grey Teal and others).

Parameter values:

Variable	Parameter	Std. Error
Constant:	-21.952367	5.608067
Species: Grey Teal	5.764250	1.756759
Time:	3.642148	0.916875

Covariance matrix of parameter estimates

31.450414		
-8.781927	3.086203	
-5.059492	1.293006	0.840660

(b) Extreme value models: $S(t) = \exp[-(\exp(t\theta) - 1) \times \exp(\underset{\sim}{\beta}'\underset{\sim}{x})]$.

(i) Single group

Parameter values:

Variable	Parameter	Std. Error
Constant:	2.955913	6.499533 *
Time:	0.000418	0.002626

* not significantly different from 0 at 5% level.

Covariance matrix of parameter estimates

42.243931	
-0.017057	6.896780E-006

For the extreme value distribution models, parameter estimates converged only for the one model, indicating a possible inadequacy in assuming an underlying extreme value distribution.

The results for Weibull model (iii) indicate an increase in hazard for Grey Teal compared to Black Duck. A plot of the survival curves for the different species is given in Figure 7. There was no significant influence from sex difference.

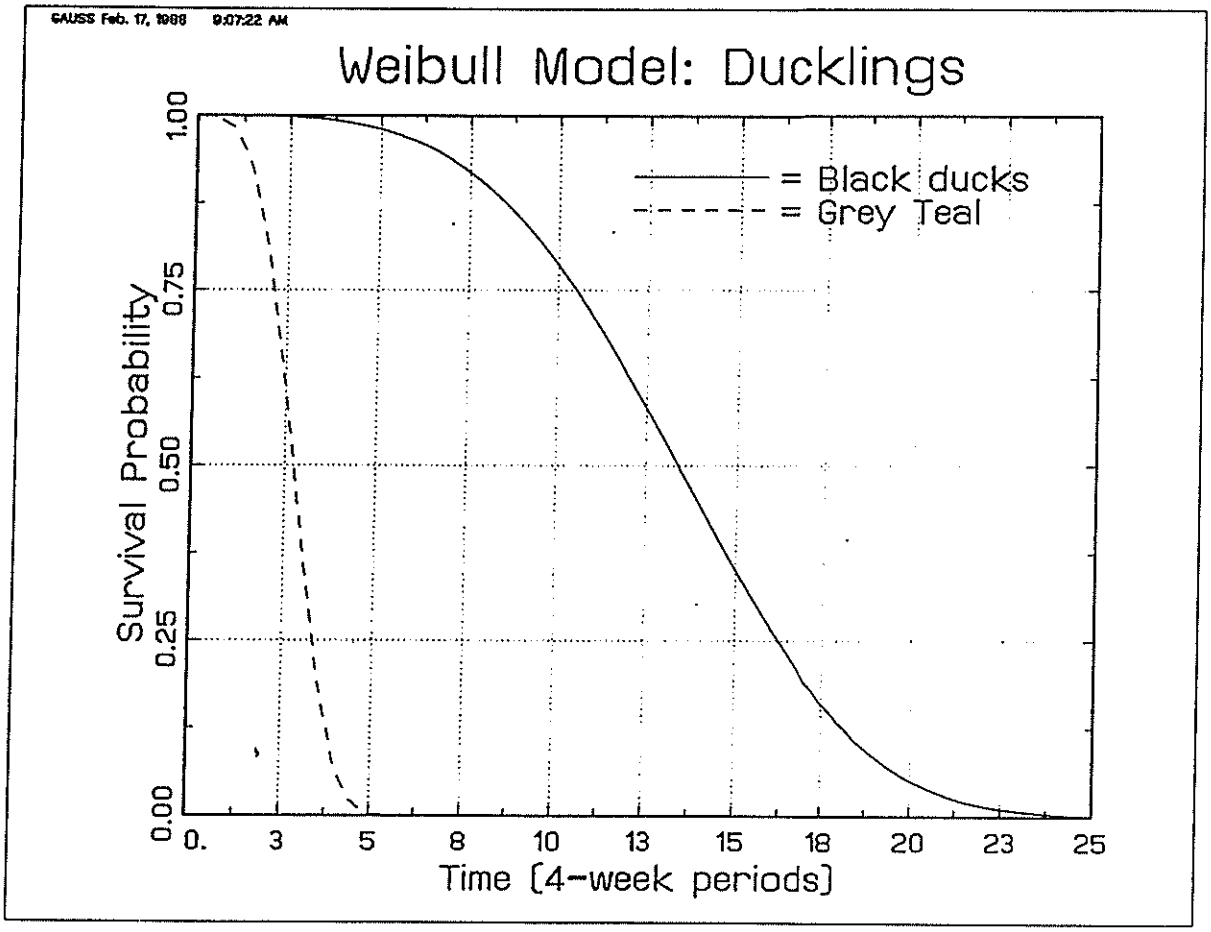

Figure 7

(II) Group first banded as juveniles.

The parameter estimates for different models for juveniles are given below, but, for brevity, the covariance matrices are included in Appendix A.

(a) Weibull models: $S(t) = \exp[-t^{\theta} \times \exp(\underset{\sim}{\beta}'\underset{\sim}{x})]$

(i) Single group.

Parameter values:

Variable	Parameter	Std. Error
Constant:	-10.772697	0.201213
Time:	1.652748	0.031749

(ii) Different species.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-10.744557	0.203103
Species:	Grey Teal	0.340256	0.118008
	Mountain D.	-0.346275	0.585172 *
Time:		1.617442	0.034172

* not significantly different from 0 at 5% level.

(iii) Different species and state (NSW and Vic for Grey Teal only).

Parameter values:

Variable		Parameter	Std. Error
Constant:		-10.748457	0.202897
Species:	Grey Teal	0.349624	0.118349
	Mountain D.	-0.346601	0.585174 *
State:	NSW	-0.330931	0.507797 *
	Victoria	-0.471182	1.007653 *
Time:		1.618166	0.034118

(iv) Different species, sex, and state - main effects only.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-11.007067	0.221922
Species:	Grey Teal	0.383131	0.118451
	Mountain D.	-0.475205	0.586678 *
State:	NSW	-0.198633	0.509878 *
	Victoria	-0.693347	1.009794 *
Sex:	Female	0.357676	0.110611
Time:		1.631496	0.034611

(v) Different species and sex.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-11.002011	0.221961
Species	Grey Teal	0.374646	0.118128
	Mountain D.	-0.473993	0.586662 *
Sex:	Female	0.354999	0.109921
Time:		1.630841	0.034659

(vi) Different species (Grey Teal and others) and sex.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-11.003350	0.221939
Species:	Grey Teal	0.388101	0.117387
Sex:	Female	0.347877	0.109719
Time:		1.629453	0.034617

(a) Extreme value models: $S(t) = \exp[-(\exp(t\theta) - 1) \times \exp(\underset{\sim}{\beta}'\underset{\sim}{x})]$

(i) Single group.

Parameter values:

Variable	Parameter	Std. Error
Constant:	-0.031892	0.149005
Time:	0.000610	6.966208E-5

(ii) Different species.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-0.179399	0.194508
Species:	Grey Teal	0.944216	0.112660
	Mountain D.	-0.115456	0.583867 *
Time:		0.000469	7.576402E-5

(iii) Different species and state (state for Grey Teal only).

Parameter values:

Variable		Parameter	Std. Error
Constant:		-0.178567	0.194813
Speices:	Grey Teal	0.941461	0.113157
	Mountain D.	-0.115455	0.583867 *
State:	NSW	0.167618	0.506885 *
	Victoria	-0.015242	1.005305 *
Time:		0.000469	7.586092E-5

(iv) Different species, state, and sex - main effects only.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-0.369997	0.207178
Species:	Grey Teal	0.956499	0.113312
	Mountain D.	-0.169904	0.584376 *
State:	NSW	0.268156	0.509156 *
	Victoria	-0.160033	1.007233 *
Sex:	Female	0.249329	0.110341
Time:		0.000497	7.727046E-5

(v) Different species and sex - main effects only.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-0.366545	0.206741
Species:	Grey Teal	0.959591	0.112831
	Mountain D.	-0.168643	0.584371 *
Sex:	Female	0.243373	0.109620
Time:		0.000497	7.713701E-5

(vi) Different species (Grey Teal and others) and sex.

Parameter values:

Variable		Parameter	Std. Error
Constant:		-0.369288	0.206671
Species:	Grey Teal	0.963467	0.112158
Sex:	Female	0.241999	0.109533
Time:		0.000497	7.716171E-5

For juveniles we have qualitatively similar results for both extreme value and Weibull models, with as before, Weibull models giving a slightly better fit.

Plots for the survival curves of different species for both distributions (based on models (a) (ii) and (b) (ii)) are given in Figures 8 and 9.

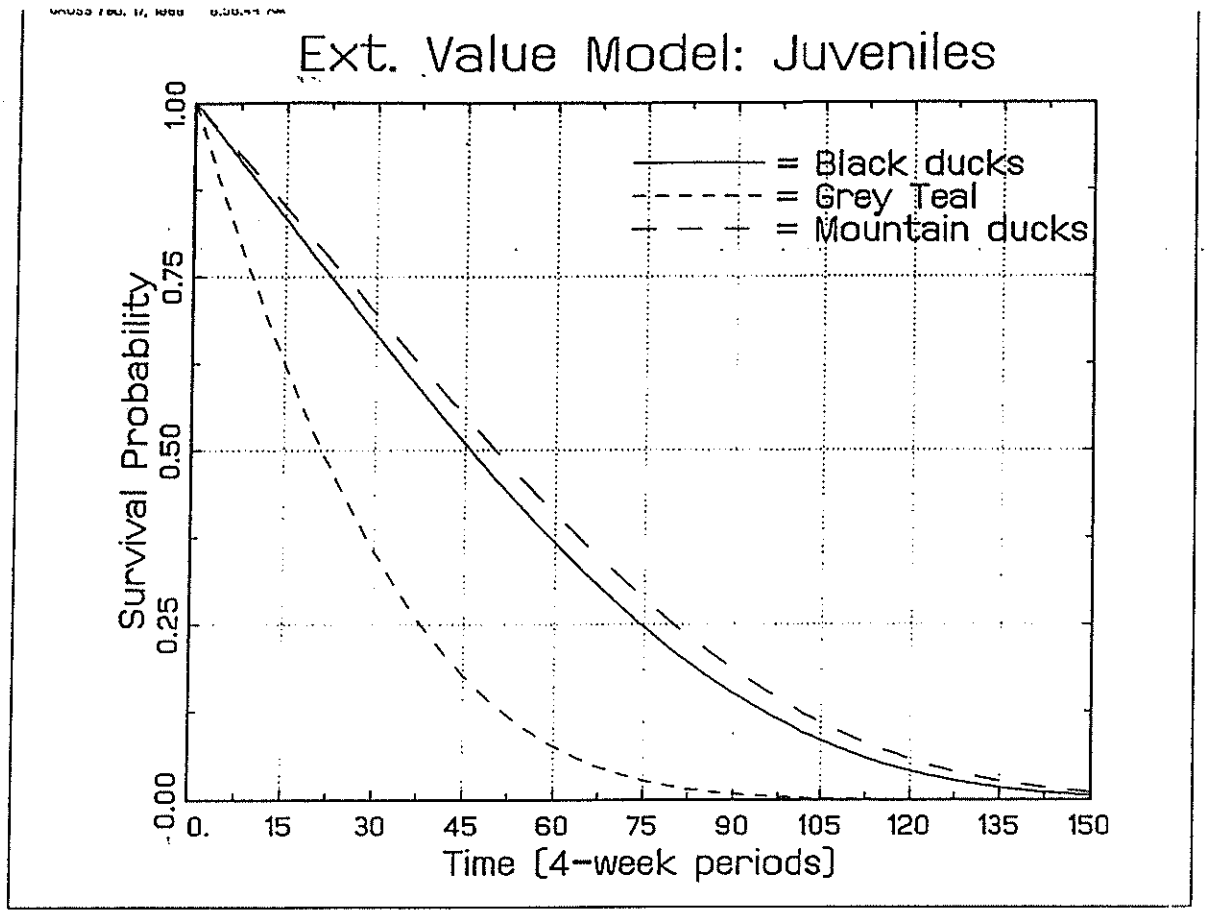

Figure 8

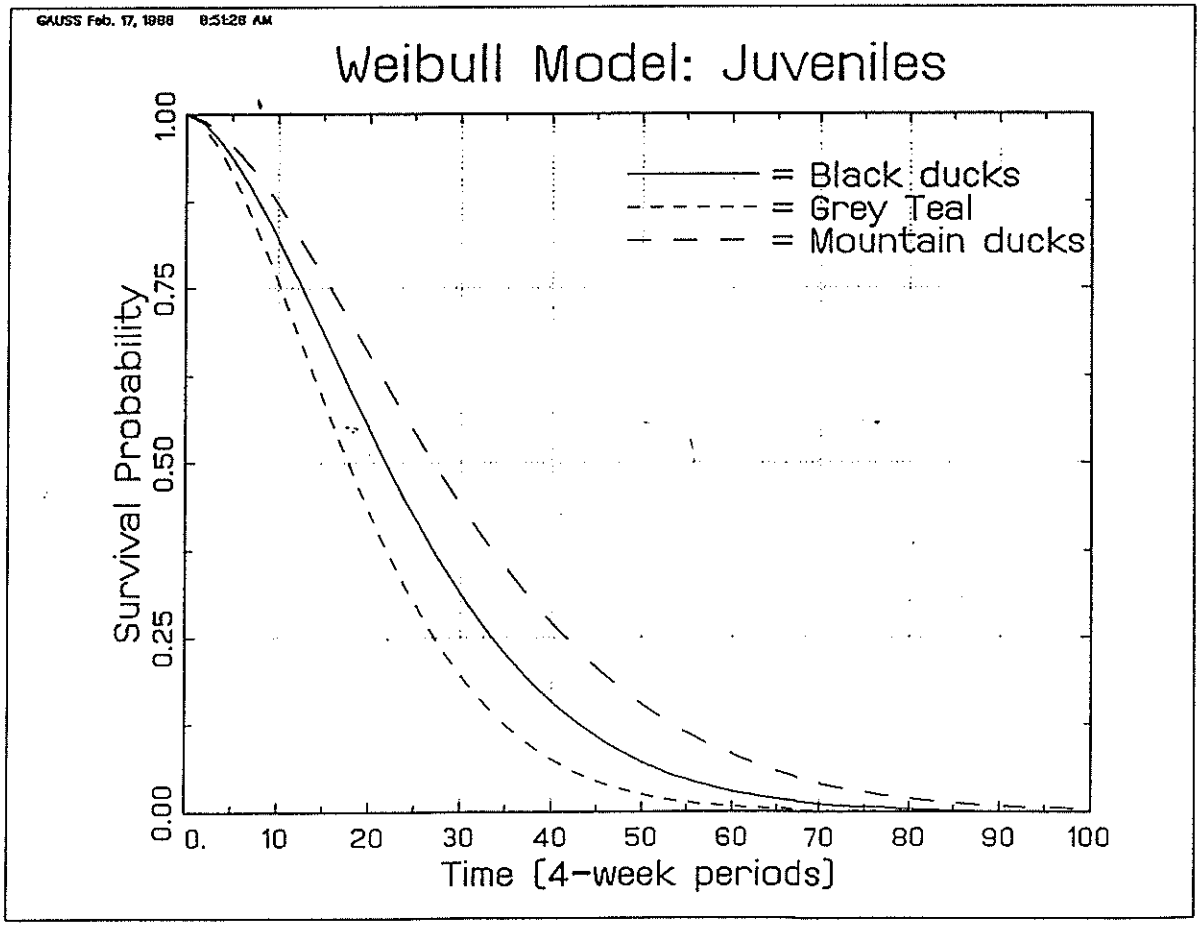

Figure 9

4.4 Discussion of the results.

With regard to the effect of parameter values, an increase in a parameter value increases the hazard, resulting in a corresponding decrease in survival probability ($S_0^{\exp(\mu)} > S_0^{\exp(\mu + \delta)}$ for $\delta > 0$). Based on this we can say the following about the above results, together with Figures 7 to 9.

Although there are very few ducks banded as ducklings, it appears from these Figures that the survival probabilities differ between this group and those banded as juveniles, with the duckling group having a much worse hazard rate than the juvenile group. Now the Weibull distribution with survival function $S(t) = \exp(-\beta t^{\theta})$ has $\mu = \Gamma(1/\theta + 1)/\beta^{1/\theta}$ and $\sigma^2 = (\Gamma(2/\theta + 1) - \Gamma(1/\theta + 1)^2)/\beta^{2/\theta}$ as its mean and variance, so that from the results on which the Figures were based, the following are the estimates for mean lifetime:

	Species		
Age Group	Black Duck	Grey Teal	Mountain Duck
Ducklings	373.83	76.80	-
Juveniles	687.31	556.92	851.39

Table 6: Mean lifetimes (in days).

Reiterating, there is a problem in the relatively low number of uncensored observations, which will have the effect of decreasing hazard rates and thus inflating survival probabilities.

As mentioned in Section 2.1, the results for the juvenile age group are probably the most relevant, and it appears that, in general the Weibull distribution provides a better fit than the extreme value distribution, so results for model (II) (a) (vi) above should be used to estimate further characteristics of the population.

Based on the results for this model ((II) (a) (vi)), there is a significant difference between Grey Teals and the other two

species of interest, with Grey Teals having the greater hazard rate. The difference between Mountain Ducks and Black Ducks is not significant but this could be due to the low number of Mountain Ducks. The effect of SEX for females, in general, to have a greater hazard rate than males. There does not appear to be any significant effect from STATE.

5. Application of results

The results presented in Section 4 (based on model (II) (a) (iv)) indicate the following Weibull model adequately describes the relationship between the factors and the survival curve for a particular group of ducks:

$$\hat{S}_T(t) = \exp[-t^{1.62945} \times \exp(-11.00335 + \hat{\beta}_{Species} + \hat{\beta}_{Sex})]$$

where

$$\hat{\beta}_{Species} = \begin{cases} 0 & \text{for Black or Mountain ducks} \\ 0.38810 & \text{for Grey Teals} \end{cases}$$

and

$$\hat{\beta}_{Sex} = \begin{cases} 0 & \text{for male ducks} \\ 0.34788 & \text{for female ducks.} \end{cases}$$

For example, the probability that a Black Duck survives beyond two years (approximately 730 days) is estimated by $\hat{S}_T(730) = \exp[-730^{1.62945} \times \exp(-11.00335)] = 0.4626$. Note that the time is in days. Similarly, for a Grey Teal, this probability is $\hat{S}_T(730) = \exp[-730^{1.62945} \times \exp(-11.00335 + 0.38810)] = 0.3210$. On the other hand, an estimate of the probability that a female Grey Teal survives at least three years is estimated by $\hat{S}(1095) = \exp[-1095^{1.62945} \times \exp(-11.00335 + 0.38810 + 0.34788)] = 0.0444$.

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Appendix A: Covariance matrices for juvenile group analysis.

(a) Weibull models.

(i)

Covariance matrix of parameter estimates

0.040487	
-0.006156	0.001008

(ii)

Covariance matrix of parameter estimates

0.041251			
0.000254	0.013926		
-0.004552	0.008024	0.342426	
-0.006289	-0.001418	-0.000526	0.001168

(iii)

Covariance matrix of parameter estimates

0.041167					
0.000162	0.014007				
-0.004562	0.008015	0.342429			
0.002318	-0.004418	0.000194	0.257858		
0.000815	-0.004754	6.8084E-5	0.004992	1.015364	
-0.006271	-0.001401	-0.000524	-0.000430	-0.000151	0.001164

(iv)

Covariance matrix of parameter estimates

0.049249						
-0.000884	0.014031					
-0.000662	0.007742	0.344191				
-0.001380	-0.003922	-0.001450	0.259976			
0.006496	-0.005407	0.002517	0.002099	1.019684		
-0.009511	0.001164	-0.004164	0.005010	-0.007109	0.012235	
-0.006748	-0.001325	-0.000808	-0.000269	-0.000458	0.000479	0.001198

(v)

Covariance matrix of parameter estimates

0.049267				
-0.000817	0.013954			
-0.000684	0.007741	0.344173		
-0.009419	0.001189	-0.004118	0.012083	
-0.006764	-0.001340	-0.000810	0.000480	0.001201

(vi)

Covariance matrix of parameter estimates

```
 0.049257
-0.000874    0.013780
-0.009399    0.001343    0.012038
-0.006759   -0.001315    0.000459    0.001198
```

(b) Extreme value models.

(i)

Covariance matrix of parameter estimates

```
 0.022203  -9.6853E-6
-9.6853E-6  4.8528E-9
```

(ii)

Covariance matrix of parameter estimates

```
 0.037833
-0.003270       0.012692
-0.007306       0.007365       0.340901
-1.3226E-5     -1.7741E-6     -2.2656E-8     5.7401E-9
```

(iii)

Covariance matrix of parameter estimates

```
 0.037952
-0.003278    0.012805
-0.007305    0.007365    0.340901
 0.001362   -0.004721    2.3676E-6   0.256932
-0.000477   -0.004966   -8.2893E-7   0.004881    1.010637
-1.3268E-5  -1.7694E-6  -2.3060E-8  -5.9087E-7   2.0686E-7  5.7548E-9
```

(iv)

Covariance matrix of parameter estimates

```
 0.042923
-0.004110    0.012840
-0.005076    0.007228    0.341495
-0.002847   -0.004395   -0.001109    0.259239
 0.004999   -0.005367    0.001429    0.001987
-0.009804    0.000736   -0.002595    0.005249
-1.3844E-5  -1.6687E-6  -4.0132E-7   2.2423E-9

 1.014518
-0.006718    0.012175
-6.2317E-7   1.4702E-6   5.9704E-9
```

(v)

Covariance matrix of parameter estimates

0.042742				
-0.004122	0.012731			
-0.005105	0.007222	-0.002565		
-0.009681	0.000761	0.012017	-0.002565	
-1.3795E-5	-1.6687E-6	1.4608E-6	-3.9744E-7	5.9501E-9

(vi)

Covariance matrix of parameter estimates

0.042713			
-0.004018	0.012579		
-0.009722	0.000826	0.011998	
-1.3815E-5	-1.6604E-6	1.4558E-6	5.9539E-9

Appendix B: Results for analyses based on all banding age groups.

B.1 Results.

The modelling of the data was carried out in the same way as the previous analyses, except that in this case all banding categories were combined into one large group.

The corresponding covariance matrices for the estimates, regarded as having secondary importance, have been included in Section B.4.

The following results were obtained for the fitted models:

(a) Weibull models: $S_T(t) = \exp[-t^{\theta} \times \exp(\underset{\sim}{\beta}' \underset{\sim}{x})]$

(i) Different species.

Variable		Estimate	Std Error
Constant:		-13.153792	0.270936
Species:	Grey Teal	1.680553	0.116253
	Mountain Duck	-0.437964	0.584382 *
Time:	Days	1.575530	0.046573

* not significantly different from 0 at 5% level.

(ii) Main effects for species and state.
(These estimates did not converge.)

Variable		Estimate	Std Error
Constant:		-13.460229	0.279263
Species:	Grey Teal	1.707516	0.115911
	Mountain Duck	-0.472831	0.584419 *
State:	NSW	0.933921	0.508067 *
	Victoria	-3.047392	1.004589
	NT	-11.115703	167.298150 *
Time:	Days	1.630954	0.048012

(iii) Species by sex plus main effects for state (NSW, and Vic).
(These estimates did not converge.)

Variable		Estimate	Std Error	
Constant:		-13.687941	0.295881	
Species:	Grey Teal	1.866519	0.161128	
	Mountain Duck	-9.251619	54.916761	
Sex:	Female	0.459152	0.171444	
Sex.Species:	Female Grey Teal	-0.329309	0.218181	*
	Female Mountain Duck	8.940328	54.919916	*
State:	NSW	0.995112	0.511778	*
	Victoria	-2.991026	1.006142	
Time:	Days	1.632033	0.048156	

(iv) Main effects for species, sex, and state (NSW and Vic).

Variable		Estimate	Std Error	
Constant:		-13.593412	0.285884	
Species:	Grey Teal	1.700869	0.115996	
	Mountain Duck	-0.537843	0.585023	*
State:	NSW	1.059248	0.510662	
	Victoria	-2.932368	1.005629	
Sex:	Female	0.265181	0.105418	
Time:	Days	1.633037	0.048109	

(v) Main effects for Grey Teal, sex, state (NSW and Vic).

Variable		Estimate	Std Error
Constant:		-13.588513	0.285897
Species:	Grey Teal	1.718519	0.114845
	NSW	1.058353	0.510651
	Victoria	-2.930505	1.005633
Sex:	Female	0.259649	0.105312
Time:	Days	1.629979	0.047982

(b) Extreme value models: $S_T(t) = \exp[-(\exp(\theta t) - 1) \times \exp(\underset{\sim}{\beta}'\underset{\sim}{x})]$

(i) Different Species.

Variable		Estimate	Std Error	
Constant:		-2.461598	0.201442	
Species:	Grey Teal	1.922301	0.111651	
	Mountain Duck	-0.132471	0.583575	*
Time:	Days	0.000490	8.347609E-5	

* not significantly different from 0 at 5% level.

(ii) Different species, states, and sex.

Variable		Estimate	Std Error
Constant:		-2.827834	0.182882
Species:	Grey Teal	1.921915	0.111828
	Mountain Duck	-0.199553	0.584031 *
State:	NSW	1.467287	0.509342
	Victoria	-2.622551	1.011449
Sex:	Female	0.243160	0.105371
Time:	Days	0.000620	8.589314E-5

(iii) Species, state, sex, and sex.species.
(Estimates did not converge.)

Variable		Estimate	Std Error
Constant:		-2.932537	0.198624
Species:	Grey Teal	2.097078	0.094922
	Mountain Duck	-11.097078	157.993654 *
State:	NSW	1.398555	0.510592
	Victoria	-2.685523	1.012475
Sex:	Female	0.449199	0.171458
Species.Sex:	Female.Grey Teal	-0 349855	0.218162 *
	Female.Mountain D.	11.141719	157.994752 *
Time	Days	0.000619	8.591681E-5

(iv) Main effects for species, sex, state.

Variable		Estimate	Std Error
Constant:		-2.830827	0.182729
Species:	Grey Teal	1.926802	0.111089
	NSW	1.466685	0.509590
	Victoria	-2.622451	1.012237
Sex:	Female	0.000619	8.573043E-5
Time:	Days	1.629979	0.047982

B.2 Discussion of results.

These results indicate the following about the factors under investigation. The comments are based on models (a) (v) and (b) (iv) above, considered to be the optimal models for each distribution in terms of the least number of parameters. Qualitatively, both distributions indicate similar conclusions.

Firstly, SPECIES is an important factor in determining the

lifetime of duck, as significant differences exist between Grey Teals and the other two species, indicated by the significantly non-zero parameter estimate corresponding to this species. However, the difference between Black and Mountain Ducks is not significant. Further, Grey Teals have a greater hazard than the other two species.

Secondly, the estimates for STATE indicate that the hazard for a duck (recall that this is for Grey Teals only) depends on where the duck is recovered, with ducks recovered in New South Wales having a greater hazard than those recovered elsewhere, and ducks recovered in Victoria have a smaller hazard than those recovered elsewhere. (Noted that only one duck was recovered in Victoria.)

Finally, the effect of SEX is significant, with female ducks having, in general, a greater hazard than male ducks.

As mentioned previously in this report, the models based on the Weibull distribution appear to fit better. Figures B.1 to B.3 below show the results for the "different species" model (results (a) and (b) (ii) above) compared to Turnbull's method results. Note that for Grey Teals (Figure B.2), the extreme value model provides a fit closer to the Turnbull results, but this is only marginal. The data for this group is the best in the sense that all three models provide a similar fit, and, as evident from Figure 2, there is no spike in the estimated hazard function of this group. For Mountain Ducks neither model fit is close to the Turnbull result. This is perhaps because it is clearly the smallest group and the results for it will be influenced strongly by the other species, in particular by Black Ducks.

B.3 Comparison with analyses by age category.

The comments made in Section 2.1 of the main report are borne out by the results obtained for these analyses. The survival probabilities at a given time increase dramatically when age at initial banding is disregarded. This leads to the conclusion that this set of results are unduely influenced by the ducks first banded at when older. They should thus be regarded with caution.

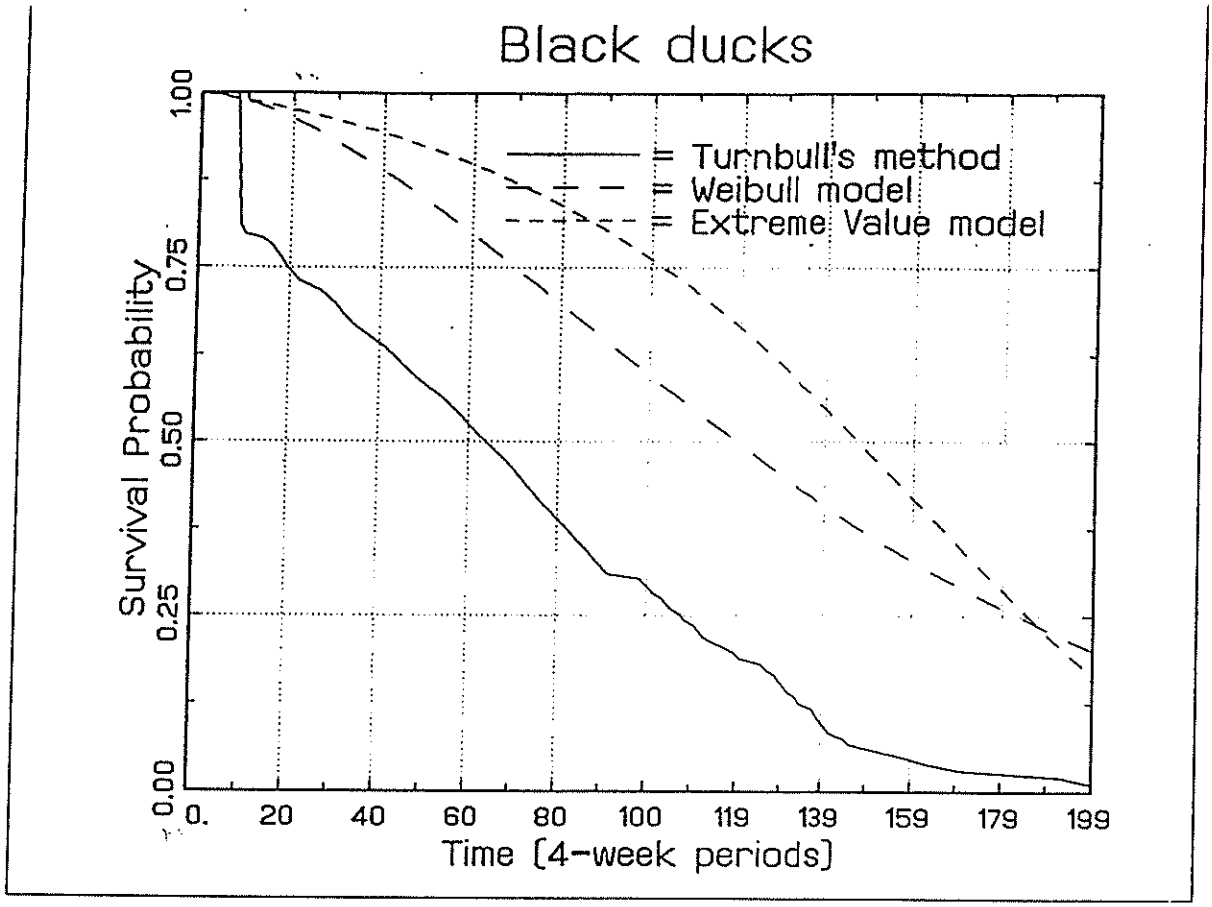

Figure B.1

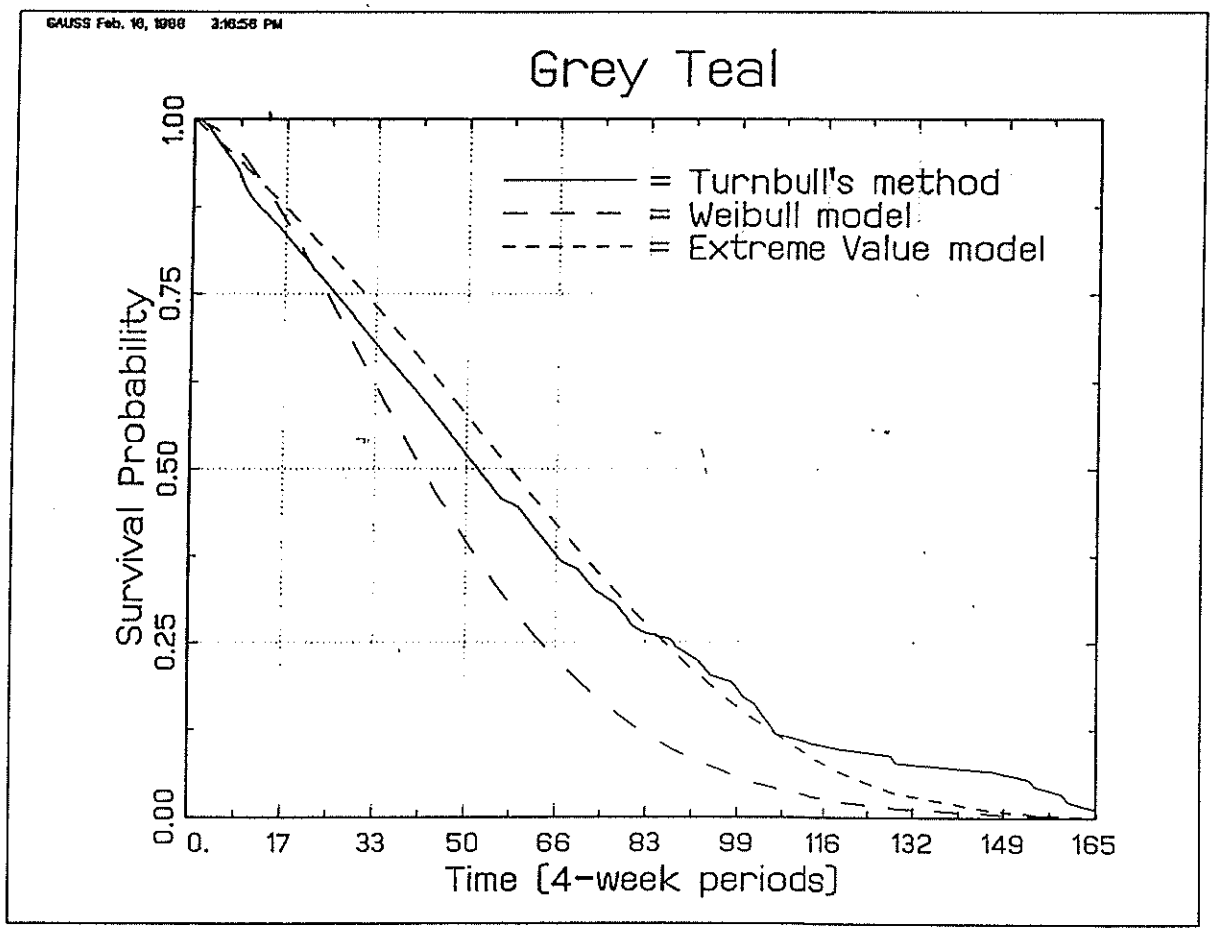

Figure B.2

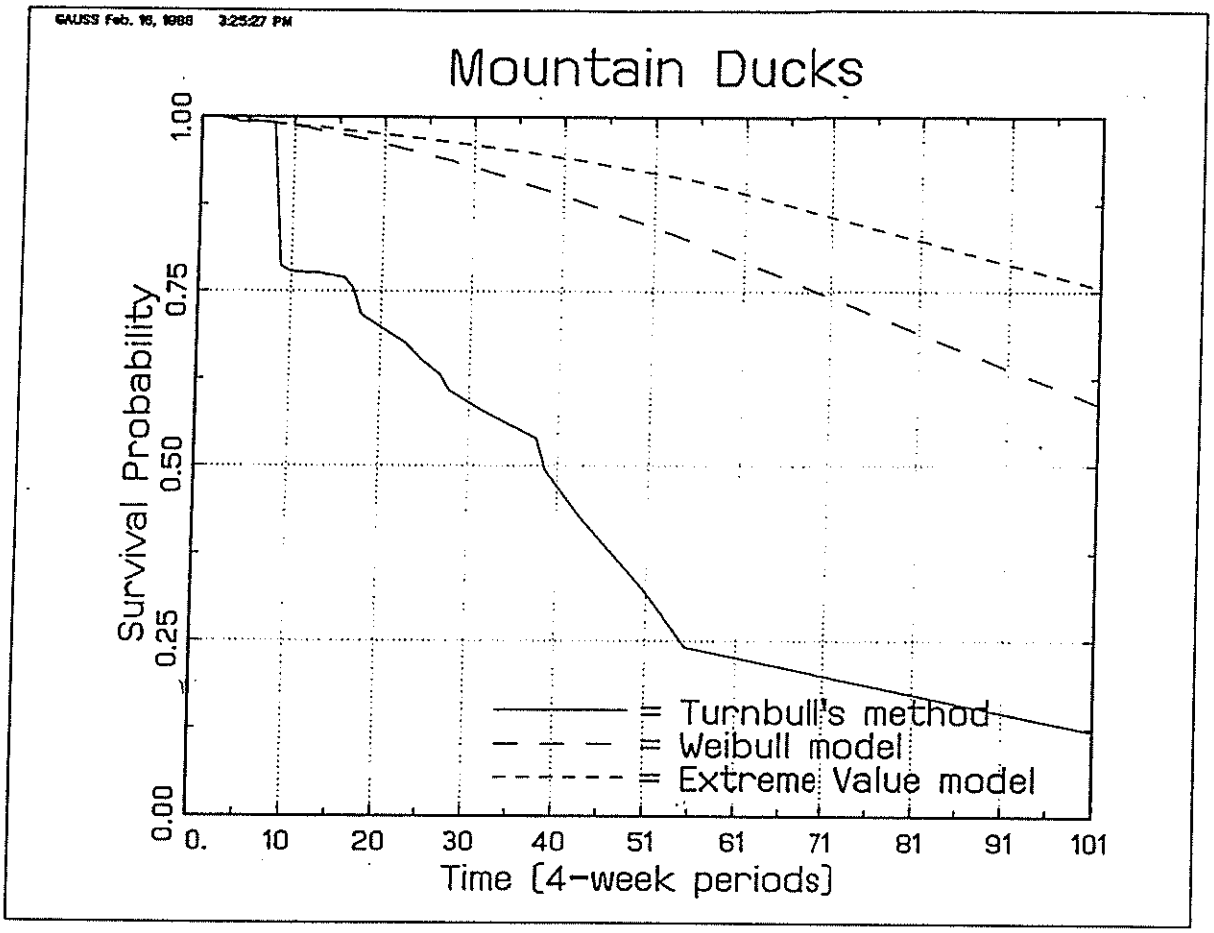

Figure B.3

B.4 Covariance matrices for models presented in Section B.1

(a) Weibull models.

(i)

0.073406			
0.003571	0.013515		
0.000254	0.008541	0.341502	
-0.011974	-0.001969	-0.001368	0.002169

(ii)

0.077988						
0.003358	0.013435					
0.000707	0.008507	0.341546				
0.007538	-0.003392	0.000854	0.258132			
0.018159	-0.001791	0.002057	0.006465	1.009198		
0.009670	-0.003071	0.001095	0.005560	0.007013	27988.67	
-0.012765	-0.001925	-0.001446	-0.001361	-0.003279	-0.001746	0.002305

(iii)

```
   0.087546
  -0.004894    0.025962
  -0.009909    0.016787    3015.850
  -0.016521    0.015774    0.015819    0.029393
   0.015500   -0.024335   -0.015904   -0.029384   0.047603
   0.019272   -0.015353   -3015.849   -0.029418   0.029370    3016.197
   0.007120   -0.007316    0.000592   -6.4339E-5  0.008367    0.000338    0.261917
   0.017819   -0.005407    0.001483   -0.000161   0.007725    0.000845    0.009907
  -0.012892   -0.001975   -0.001073    0.000116   6.7142E-5  -0.000611   -0.001281

   1.012321
  -0.003205    0.002319
```

(iv)

```
   0.081730
   0.003522    0.013455
   0.002458    0.008585    0.342252
   0.004481   -0.003466   -0.000441    0.260776
   0.015301   -0.001865    0.008832    0.000909    1.011289
  -0.006316   -0.000167   -0.002706    0.005411    0.004878    0.011113
  -0.012886   -0.001940   -0.001290   -0.001523   -0.003198    0.000154    0.002314
```

(v)

```
   0.081737
   0.003269    0.013189
   0.004542   -0.003444    0.260764
   0.015338   -0.001907    0.008840    1.011297
  -0.006260   -5.0426E-5   0.005399    0.004886    0.011091
  -0.012861   -0.001869   -0.001302   -0.003199    0.000131    0.002303
```

(b) Extreme value models

(i)

```
   0.040579
  -0.002316    0.012466
  -0.005715    0.007533    0.340560
  -1.5228E-5  -2.2789E-6  -7.2369E-7   6.968258E-9
```

(ii)

```
   0.033446
  -0.003241    0.012505
  -0.004626    0.007571    0.341092
  -0.000978   -0.004279   -0.001089    0.259429
   0.017521   -0.001154    0.000160    0.008533    1.023029
  -0.005926   -0.000181   -0.002442    0.005479    0.004686
  -1.3167E-5  -2.2457E-6  -8.3629E-7  -9.6230E-7  -1.1218E-5

   0.011103
   2.8302E-7   7.3776E-9
```

(iii)

0.039452					
-0.011860	0.024961				
-0.015351	0.015962	24961.99			
0.001722	-0.008112	3.8112E-5	0.260704		
0.020143	-0.004712	0.000446	0.009613	1.025106	
-0.016379	0.015787	0.015862	-3.6945E-5	-0.000432	0.029398
0.015863	-0.024277	-0.015873	0.008402	0.007822	-0.029387
0.017253	-0.015638	-24961.99	0.000101	0.001179	-0.029416
-1.3192E-5	-2.2456E-6	-2.9191E-7	-9.6373E-7	-1.1270E-5	2.8298E-7

0.047595		
0.029386	24962.34	
5.7102E-9	-7.7199E-7	7.381699E-9

(iv)

0.033390					
-0.003171	0.012341				
-0.000992	-0.004255	0.259682			
0.017470	-0.001182	0.008536	1.024623		
-0.005965	-0.000115	0.005473	0.004694	0.011095	
-1.3153E-5	-2.2121E-6	-9.6597E-7	-1.1171E-5	2.7303E-7	7.3497E-9

Ext 63

THE UNIVERSITY OF WESTERN AUSTRALIA STATISTICAL CONSULTING GROUP

Department of Mathematics · Nedlands · WA 6009 · Tel: (09) 380-3346

23 December 1987

Dr. Stuart Halse
WA Wildlife Research Centre
PO Box 51
Wanneroo W.A. 6065

Dear Stuart

not put in file, will await final copy

Enclosed is another rough draft of the revamped tables for the Duck Tagging Project. As with the last two reports, this will be revised and modified in the light of our own re-reading and any comments we receive from you, before it is incorporated into the unified final report.

We look forward to hearing from you in the New Year. We must arrange a meeting to review the overall progress and define any aspects which remain to be considered. I'll be in touch.

All the best for the Festive Season, and happy reading.

Sincerely

Ian James
Director

15/12/87 280 62

Dear Stuart,

I enclose a preliminary copy of the report on the work I've been doing. (not put on file, will await final copy)
Regarding the results, I suspect that the data provided leads to ~~an~~ overestimation of lifetimes – a problem that you mentioned previously.
The method of analysis has been thoroughly checked (using other, better behaved data).
The figures, although not incorporated in the body of the report as yet are in the order ~~give~~ referred to in the report.
The numerical results may vary somewhat once the corrections which have to be made to the data are included, but the differences should be slight.

I will be taking some leave starting tomorrow so could you please direct any (immediate) queries you have to either Ian or Dean. I will be back at work when UNA reopens on January the 8th.

Regards + best wishes for the season

Pat FitzGerald

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

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Dear Kim

STATES ASSISTANCE PROGRAM
PROJECT NO. 4460 - DUCK BANDING ANALYSIS

Following my letter of 3rd December enclosing a copy of the draft report on survival analysis of ducks using life-table analysis, I am now sending a copy of a draft report on survival analysis of Pacific Black Duck, Grey Teal and Australian Shelduck using a non-parametric method developed by the Statistical Consulting Group.

At this stage I have not gone through the report thoroughly myself but it appears that the survival estimates are too high. However, they provide food for thought when compared with more conventional analyses that yield population structures that are barely sustainable without very high and regular recruitment. We will certainly fiddle a little more with the data used in this model before producing the final report and this may have a substantial effect on the results.

I would also like to notify you that the project will not be completed by the end of 1987. Although we are making excellent progress, I do not anticipate completion prior to April 1988, i.e. the project will run twelve months. We will submit a final report at this time.

Finally, please find enclosed a band from a giant petrel found on the southern side of Point Cloates, Western Australia, approximately 100 m inland. Only skeletal remains of the bird were found. These consisted of the leg bone to which the band is attached, the skull and bill, a wing bone and other smaller bones. The remains were found on 1st July 1987 by

cont'd...

2/...

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3 Moush Place
MANDURAH
WESTERN AUSTRALIA 6210

Ph. 535 2924

Yours sincerely

Stuart Halse.

DR STUART HALSE
Senior Research Scientist

December 18, 1987

Vogelwarte
Hiddensee
DDR/FAP/GDR
223105

247

59

The Director
Australian National Parks and
Wildlife Service
P.O. Box 636
CANBERRA ACT 2607

ATTN: Dr K. Lowe

Dear Kim

STATES ASSISTANCE PROGRAM
PROJECT NO. 4460 - DUCK BANDING ANALYSIS

not part on file, will wait for final copy

Please find enclosed a copy of a draft report on survival analysis of Pacific Black Duck, Grey Teal and Australian Shelduck, which the Statistical Consulting Group has submitted as part of the duck-banding analysis. This report covers conventional life-table analyses, such as used in almost all previously published work. We will complete analyses using an alternative method soon (see p.24).

Only the results for Pacific Black Duck and Grey Teal are of interest; those for Australian Shelduck are meaningless because there are too few data. However, the results for black duck and teal tie-in well with other published work and are consistent with the results from our alternative analysis, so I think we have something useful. You may also find the background material interesting.

I have enclosed a sheet listing the fields we now have in the data set. This should be read in conjunction with the documentation I sent earlier. Those notes cover fields 1-25; we have added 26-32 for our own use. I have also included samples of the 9, 11 and 15 mm bands that were used for Western Australian duck-banding - they are in the small envelope. Nine millimetre bands were used mostly on Grey Teal, 11 mm on Pacific Black Duck and 15 mm on Australian Shelduck. Dr Tom Riggert did the bulk of the banding.

Yours sincerely

DR STUART HALSE
Senior Research Scientist

December 3, 1987

Department of Conservation and Land Management
Western Australia

Kim, Si have bee

ND LAND MANAGEMENT

ERN AUSTRALIAN WILDLIFE
EARCH CENTRE
AN REEF ROAD
ODVALE
one (09) 405 1555

Ocean Reef Road
Woodvale
Telephone (09) 405 1555

245

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Your Ref:
Our Ref:
Enquiries:

Dr Kim Lowe
Australian Bird Banding Scheme
Australian National Parks &
Wildlife Service
PO Box 636
CANBERRA CITY ACT 2601

Postal Address
PO Box 51
WANNEROO W.A. 6065
Facsimile (09) 306 1641
Telex AA94616

Dear Kim

Please find enclosed a copy of the printout of the first 100 lines of data in the duck-banding data set we are working on. I have also included a copy of the documentation for the data set. The early records are full of blanks because not much was recorded; the data from 1969 onwards are more complete.

I hope you can make sense of the fields in the data set. As I said over the 'phone, we would be happy to do some manipulation while we are working with the data to put it in a more convenient form for you. Please let me know what suits you.

The other purpose of this letter is to ask whether it would be possible to get the data pertaining to ducks banded outside W.A. but recovered in this State. Hugo Bekle recently told me that a lot of Grey Teal were banded in the Northern Territory (I think at Humpty Doo) and recovered in south-western W.A. Dr Braithwaite told me that this was work done in the 1950s by Frith. I am very keen to get hold of this information and any other that exists on Grey Teal or Pacific Black Duck banded elsewhere and recovered in W.A. The crucial information associated with these birds is the location and date they were last sighted outside the State and the location and date of their recovery in W.A. Additional information on age, sex and other sightings (i.e. recaptures) would also be useful.

I have approached Dr Norman in Victoria for information from his banding programme and will soon be writing to the Tasmanian National Parks & Wildlife Service.

Yours sincerely

Stuart Halse

rang Hugh Harvey, chatted + he sent some of his relevant papers

DR S.A. HALSE
SENIOR RESEARCH SCIENTIST

April 28, 1987

NATIONAL PARKS AND WILDLIFE SERVICE

Enquiries to: S. Blackhall,
Phone (002) 30 6578
Please Quote: W60/10/2

P.O. Box 210
SANDY BAY, 7005
TASMANIA
Telegrams: TASPAWS
Fax: (002) 23 8308

18th May, 1987.

Dr. S. A. Halse,
Senior Research Scientist,
Western Australia Wildlife Research Centre,
P. O. Box 51,
WANNEROO. W.A. 6065.

Dear Sir,

In response to your letter of April 28th requesting information about ducks banded in Tasmania, I can find no record of any band return from Western Australia. Only relatively small numbers of birds were banded here between 1957 and 1970 (approx. 500 grey teal and 750 black ducks) but the movement of these birds was predominantly north-south also. Substantial numbers, up to 35%, in some years were harvested in Victoria and up to 20% in N.S.W. Much smaller numbers have been recovered in S.A. and in 1964 one grey teal band was returned from Queensland.

I hope this information will be useful to you.

Yours faithfully,

S. A. Blackhall

for R. H. Annells,
SECRETARY.

wp4/2L/58

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Please address all enquiries to:

WESTERN AUSTRALIAN WILDLIFE
RESEARCH CENTRE
OCEAN REEF ROAD
WOODVALE
Phone (09) 405 1555

Your Ref:
Our Ref:
Enquiries:

The Director
Tasmanian National Parks & Wildlife Service
PO Box 210
SANDY BAY TAS 7005

Postal Address
PO Box 51
WANNEROO W.A. 6065
Facsimile (09) 306 1641
Telex AA94616

Dear Sir

I recently received a grant from ANPWS under the States Assistance Program to analyse the results of a banding program on Grey Teal and Pacific Black Duck that this department ran from the mid-1950s to 1970s. Most of the banding was carried out between 1969-75 by Dr Tom Riggert.

Although the principal objective of the study is to determine survival rates in the two species I am also examining patterns of movement and the factors influencing long distance movements. Most of these movements in Western Australia birds seem to be north-south rather than east-west but a reasonable number of ducks banded in W.A. were recovered in Victoria and New South Wales. Movement in the opposite direction has been recorded in ducks banded in Victoria.

The purpose of this letter is to ask whether any Grey Teal or Pacific Black Duck banded in Tasmania have been recovered in W.A. If so, I would be extremely appreciative of information concerning the locality and date of banding in Tasmania, the locality and last date when it was handled, and the locality and date of recovery in W.A.

Yours faithfully

Stuart A Halse.

DR S.A. HALSE
SENIOR RESEARCH SCIENTIST

April 28, 1987

025840F2112 ✓✓
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AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE

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217 Northbourne Avenue
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P.O. Box 1260
Darwin, N.T. 5794
Ground Floor, Commercial Union Building.
Smith Street, Darwin, N.T. 5794
Phone (089) 81 5299
Telex AA85130

Shea 5/12

Jim Lane 4/12

copy for your attention.
Plse direct to project file. KMcN. 30/11

Our ref: 120/7/22
Your ref: GS:TW

Department of Conservation and Land Management
25 NOV 1987
COMO, W.A.

16 November 1987

Dr. S. Shea
Executive Director
Department of Conservation &
Land Management
P.O. Box 104
COMO W.A. 6152

Department of Conservation and Land Management
24 NOV 1987
COMO, W.A.

Attention: Mr. Keiran McNamara

Dear Dr. Shea,

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1987/88

I refer to your letter 022098F2112 of 22 October 1987 in which you accepted the ANPWS offer of financial assistance for five projects to be conducted under the States Co-operative Assistance Program in 1987/88. — PV

For one of the five projects, Duck Banding Data Analysis, the full amount of $18,000 has been provided to you already (see my letter 120/7/22 of 13 August 1987).

Funding for the other four projects will be made available according to the following schedule:

	Nov.87	Dec.87	July 88
	$	$	$
Kangaroo-paws	7,500	10,700	0
Endangered Eucalypts	14,500	20,500	9,000
Ningaloo Research	10,000	15,000	0
Marine Turtles	9,000	13,000	0
	$41,000	$59,200	$9,000

Please find enclosed a cheque for $41,000 to cover the November payment. Also enclosed are the General Conditions relating to all projects conducted under the Program and the Project Specifications for each project.

Rec 731 $41,000.00 24/11/87

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24T SL

I draw your attention particularly to the first two paragraphs of the General Conditions, which are worded to take account of the fact that for some projects ANPWS commitment of funds now extends into next financial year. For the five projects conducted by your Service, the dates to which these General Conditions relate are as follows:

	Completion Date	Acquittance Date	Date for Return of Unused Funds
Duck Banding	30/6/88	7/ 7/88	20/6/88
Kangaroo Paws	30/6/88	7/ 7/88	20/6/88
Endangered Eucalypts	30/9/88	7/10/88	7/10/88
Ningaloo Research	30/6/88	7/ 7/88	20/6/88
Marine Turtles	30/6/88	7/ 7/88	20/6/88

In all cases, ANPWS is to be advised no later than one month before the Completion Date if it is anticipated that any of the funds provided by ANPWS will not be used. Please advise me as soon as possible if you foresee any difficulties in fulfilling these requirements.

As in previous years, ANPWS has nominated Project Officers for all projects. Their names are included on the Project Specifications. They are required to liaise with the officers of your Service who are implementing projects, in order to ensure satisfactory progress is being achieved, and to provide technical advice when appropriate. In addition, Dr. Gwen Shaughnessy (062 466620) is the ANPWS Co-ordinator for the whole program.

I am pleased that our two agencies are able to co-operate on these nationally significant projects and I look forward to seeing the final reports on the results achieved.

Yours sincerely

J.D.O.

Professor J. D. Ovington
Director

27.11.87.

1 Mr K McNamara.
2. Mr. A. Burnett.

Copied (incl attachments) to B. Wilson, G. Mercer, J. Lane, S. Hopper, R. Prince, K. Morris & S. Fritz. KMcN - 30/11

2T
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STATES CO-OPERATIVE ASSISTANCE PROGRAM 1987/88
CO-OPERATIVE PROGRAM BETWEEN THE AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE (ANPWS) AND THE WESTERN AUSTRALIAN DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT (WADCALM)

GENERAL CONDITIONS
RELATING TO EACH PROJECT CONDUCTED UNDER THE PROGRAM

1. For each project ANPWS, in consultation with WADCALM, shall compile Project Specifications which state, inter alia, the Completion Date for the project. Unless otherwise agreed in writing by the Director ANPWS, each project is to be completed by the Completion Date.

2. ANPWS is to be advised no later than one month before the Completion Date if it is anticipated that any of the funds provided by ANPWS for the project will not be utilised. For projects with a Completion Date of 30 June 1988, reimbursement of those unutilised funds must be made no later than 20 June 1988. For all projects, an acquittance of funds stating that funds have been expended in accordance with the Project Specifications must be forwarded to ANPWS no later than seven days after the Completion Date. For projects with a Completion Date other than 30 June 1988, any unutilised funds not previously reimbursed must accompany the acquittance.

3. The assistance is provided by ANPWS on the understanding that involved parties may each use the results of the project and any related material for purposes connected with their respective statutory functions. Any publications resulting from the project must acknowledge the assistance given by ANPWS.

4. ANPWS is to be provided with six copies of any report, plan of management or other written document produced as part of a project.

5. Staff are to be engaged by WADCALM and shall not thereby become in the service or employment of the Commonwealth. WADCALM shall be responsible for effecting all insurances required under Worker's Compensation legislation and for taking all other such action requisite as employer in relation to WADCALM employees engaged in the project.

6. The WADCALM shall indemnify and keep indemnified the Director ANPWS from and against any claim, demand, action, suit or proceeding that may be made or brought by any person against the Director ANPWS or the employees or agents of the Director ANPWS or any of them in respect of personal injury to or the death of any person whomsoever or loss of or damage to any property or any other loss or damage whatsoever arising out of or as a consequence of an unlawful act or a negligent act or omission by WADCALM or its employees or agents in the course of carrying out the project and also from any costs and expenses that may be incurred with any such claim, demand, action, suit or proceeding.

Your Department's acquittals for the seven projects conducted under this program in 1986/87 are still outstanding. These need to be finalised before any commitment to new funding can be made by this Service.

Yours sincerely

J. D. Ovington

Professor J. D. Ovington
Director

28T 42

AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE

HEAD OFFICE
G.P.O. Box 636
Canberra, A.C.T. 2601
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217 Northbourne Avenue
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Smith Street, Darwin, N.T. 5794
Phone (089) 81 5299
Telex AA85130

Our ref:
Your ref: 120/7/22
GS:TW

13 August 1987

Dr. S. Shea,
Executive Director
Department of Conservation
and Land Management,
P.O. Box 104,
COMO W.A. 6152

Attention: Mr. K. McNamara

Dear Dr. Shea,

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1987/88
PROJECT ON DUCK BANDING DATA ANALYSIS

I refer to my letter 120/7/18 of 24 February 1987 concerning assistance provided by this Service for a project to analyse the duck banding data held by your Department.

As satisfactory progress has been achieved with this project, I am pleased to provide a further $18,000 to enable it to be completed this year. A cheque for that amount is enclosed.

Also enclosed are the General Conditions applying to projects conducted under this program and the Project Specifications.

Dr. Kim Lowe, as ANPWS Project Officer, will continue to liaise with Mr. Jim Lane and Dr. Stuart Halse of your Department.

I look forward to learning the results of this project, which should assist in the identification of important wetlands.

With respect to the other projects proposed by your Department for the States Co-operative Assistance Program this year, in your letter 002098F2112 of 25 May 1987, I must advise that no commitment can be made by this Service until our budget situation is clear.

Rec 5430

R. I. S. Misc.

ATTACHMENT 1
120/7/22

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1987/88
CO-OPERATIVE PROGRAM BETWEEN THE AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE (ANPWS) AND THE WESTERN AUSTRALIAN DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT (WADCALM)

GENERAL CONDITIONS
RELATING TO EACH PROJECT CONDUCTED UNDER THE PROGRAM

1. Unless otherwise agreed in writing by the Director ANPWS, each project is to be completed by 30 June 1988. ANPWS is to be advised by 1 June 1988 if any of the funds provided by ANPWS in 1987/88 will not be utilised and reimbursement to ANPWS of those unutilised funds must be made by 20 June 1988. A written acquittal that all funds have been expended in accordance with the project specification must be forwarded to ANPWS by 7 July 1988.

2. The assistance is provided on the understanding that involved parties may each use the results of the project and any related material for purposes connected with their respective statutory functions. Any publications resulting from the project must acknowledge the assistance given by ANPWS.

3. ANPWS is to be provided with six copies of any report, plan of management or other written document produced as part of a project.

4. Staff are to be engaged by WADCALM and shall not thereby become in the service or employment of the Commonwealth. WADCALM shall be responsible for effecting all insurances required under Worker's Compensation legislation and for taking all other such action requisite as employer in relation to WADCALM employees engaged in the project.

5. WADCALM and its employees and agents shall indemnify and keep indemnified the Commonwealth from and against any claim, demand, action, suit or proceeding that may be made or brought by any person against the Commonwealth or the employees or agents of the Commonwealth or any of them in respect of personal injury to or the death of any person whatsoever or loss of or damage to any property or any other loss or damage whatsoever arising out of or as a consequence of an unlawful act or a negligent act or omission by WADCALM or its employees or agents in the course of carrying out the project and also from any costs and expenses that may be incurred with any such claim, demand, action, suit or proceeding.

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1987/88

PROJECT SPECIFICATIONS

For a Co-operative Project Involving Australian National Parks and Wildlife Service (ANPWS) and Western Australian Dept of Conservation & Land Management (WADCALM)

PROJECT NO: 4460.

PROJECT TITLE: Duck Banding Data Analysis, Stage 2.

PROJECT OUTLINE:

. Complete a study involving:

- analysis of banding and recovery data from ducks banded by WA Fisheries and Wildlife Dept;
- use of data on sex, age, weight and moult to elucidate movements, survival rates, seasonal weight changes and moulting activity of the banded ducks.
- an attempt to assess hunting mortality from these data;
- a final report including details and results of analyses; and
- supply of banding, recovery and measurement data to the Australian Bird Banding Scheme in appropriate format.

. Submit the final report by December 1987.

PROJECT DURATION: To 31 December 1987.

PROJECT SUPERVISOR: Mr Jim Lane (WADCALM), Woodvale, (09) 405 1555.

PROJECT OFFICERS:
WADCALM - Dr S. A. Halse, Woodvale, (09) 405 1555.
ANPWS - Dr Kim Lowe, Canberra, (062) 46 6304.

AGENCY INPUTS 1987/88:
ANPWS - $18,000; technical advice.
WADCALM - Project supervision; computerised banding data; technical & administrative support.

[Compiled: July 1987]

FILE REFERENCE NUMBER (02/4788F0404) 728 — 39

RECORDS

FILE REQUEST FORM

FILE REQUEST FOR: S Halse (Woodvale)

MARKED TO: J Blythe **DATE:** 5.6.87

NAME OF FILE: Duck Banding Project

ANPWS

DATE OF REQUEST: 24.6.87

Dry Store Box Number _____

M Clarke, Rm 203 3/7/87

Can you please make the second payment of $60000-00 asap (see p. 220) to the Statistical Consulting Group

Executive clerk
Please process attached
Form 10 no 350147

Stuart

PAID ON BATCH No. 153
ITEM
EXPENDITURE SECTION

cleared with Audrey today a payment in advance of contract (may appear in Sep Estimates funding allocation 28/7/87

FILED
- 5 AUG 1987
By

~~276~~ 37

The Director
Australian National Parks
and Wildlife Service
P.O. Box 636
CANBERRA CITY ACT 2601

ATTN: DR K. LOWE

Dear Sir

STATES ASSISTANCE PROGRAM 1986/87
PROJECT NO. 4460 - DUCK BANDING DATA ANALYSIS, STAGE 1

Following my progress report of 22nd June, please find enclosed the first interim report by the Statistical Consulting Group. This covers the correcting of errors and inconsistencies in the data, some reco ding of information, and the production of some preliminary frequency and cross-tabulation tables.

Yours faithfully

DR S.A. HALSE
Senior Research Scientist

July 6, 1987

215 316

THE UNIVERSITY OF WESTERN AUSTRALIA

Statistical Consulting Group

Department of Mathematics
Nedlands WA 6009 Australia

Telephone: (09)380-3346
Telex: AA92992

2 July 1987

Dr Stuart Halse
WA Wildlife Research Centre
PO Box 51
WANNEROO WA 6065

Dear Stuart

Duck Banding Programme

We enclose copies of our interim report summarising the data preparation and checking phase of the analysis. This has taken rather longer than first anticipated, but the file now appears to be in a sound condition for further analyses.

We have included a small number of summary tables for interest. Further tables split by numerous options can be readily produced at this stage, but we decided not to churn out too many until we have a chance to discuss the particular combinations of interest - hence the relatively thin report.

Work on the preparation of software to estimate survival of the ducks has been progressing smoothly also, and we are now in a position to apply it to some of the data.

I will be in touch early next week to arrange a meeting to discuss particular aspects of the next stages of the project.

Sincerely

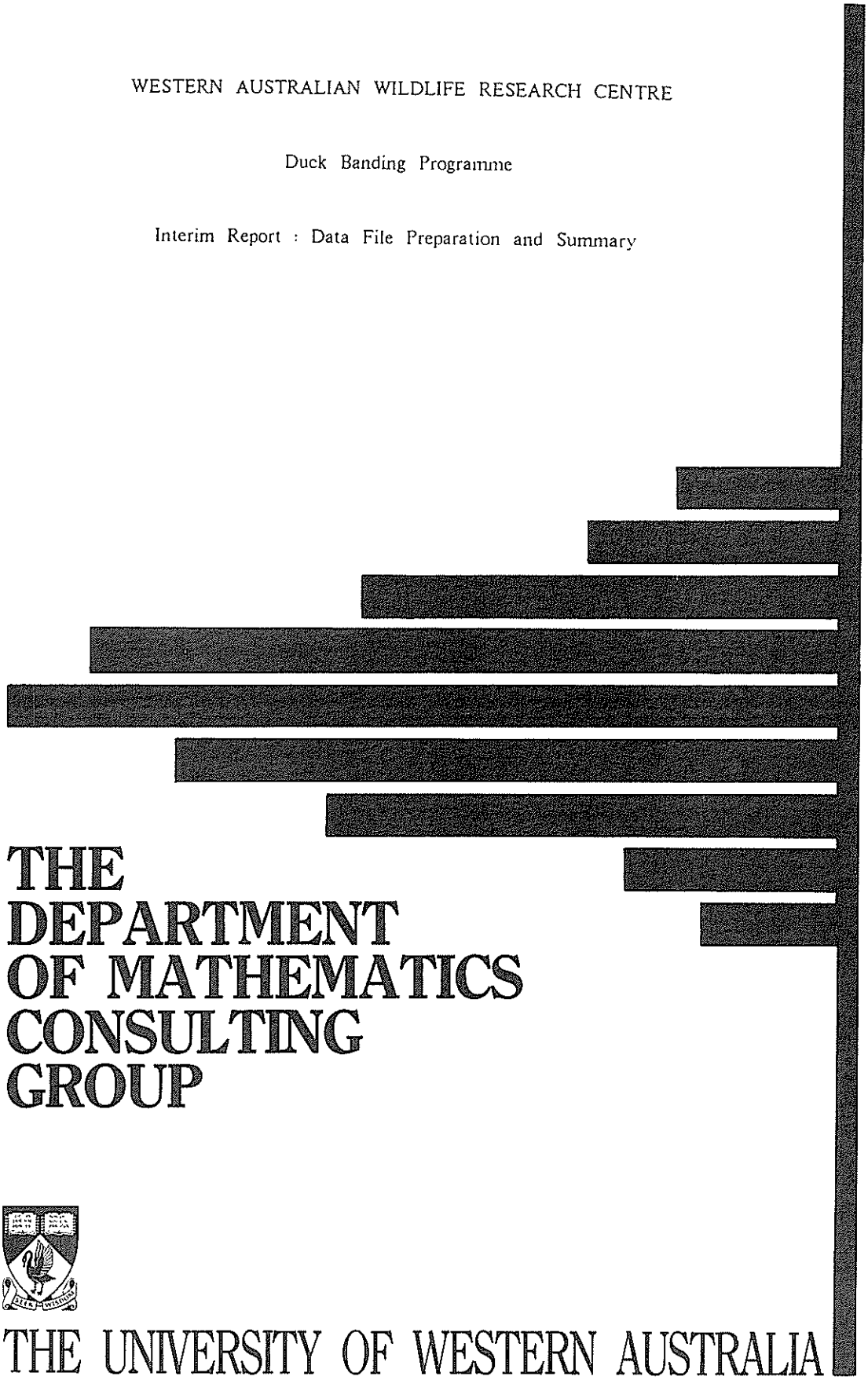
Ian James
Director

224 35

WESTERN AUSTRALIAN WILDLIFE RESEARCH CENTRE

Duck Banding Programme

Interim Report : Data File Preparation and Summary



THE DEPARTMENT OF MATHEMATICS CONSULTING GROUP

THE UNIVERSITY OF WESTERN AUSTRALIA

WESTERN AUSTRALIAN WILDLIFE RESEARCH CENTRE

Duck Banding Programme

Interim Report : Data File Preparation and Summary

Report prepared for : Western Australian Wildlife Research Centre
Ocean Reef Road, Woodvale WA
(Dr. Stuart Halse)

By : D.A. Diepeveen
I.R. James
Statistical Consulting Group
University of Western Australia

July 1987

Statistical Consulting Group

WESTERN AUSTRALIAN WILDLIFE RESEARCH CENTRE

Duck Banding Programme

Interim Report : Data file preparation and summary

CONTENTS:

Duck Banding Data File

1. INTRODUCTION

This interim report briefly summarises progress on data correction and modification procedures for the Wildlife Research duck banding data file, which initially consisted of 41,176 records.

Comprehensive data checking procedures have been implemented to detect inconsistencies and duplications in the file, and all of these have been investigated in conjunction with the WA Wildlife Research Centre and corrected as far as possible. This process has been time consuming, but has led, with additional modifications to the original coded values, to a clean data file which will enable efficient further analyses.

No detailed analyses are presented in the present report, but we include in §3 frequency tabulations of the main variables of interest and selected cross tabulations of some of them. Other cross tabulations and detailed analyses, such as survival analyses, which are underway, will be reported separately as they are completed. In §2 we briefly outline the modifications found to be necessary or desirable.

2. DATA CORRECTION AND RECODES

The data file originally provided consisted of 41176 records of banded ducks with coding as described in the document "Duck Banding Programme : Coding and Computing System Documentation". The records included recapture data from 1953 to 1985. Information on approximately 60 further ducks was added to the file subsequently.

Initial investigation of the data indicated many cases of inconsistencies (eg apparent sex changes between recaptures) and considerable duplication in the records. In addition, for the purposes of analysis it is desirable to accumulate all information on a single duck together in a single location rather than have information scattered throughout the file. The strategy adopted was to identify all records belonging to a particular duck, rearrange the file so that they formed consecutive records, then to check for consistency of codes

within records and across records. Where modifications were needed, the following conventions were adopted (after discussion with Wildlife Research). Note that in the subsequent discussion the term "recapture" will be used to denote both recaptures (ie. live captures and releases) and recoveries (ie. dead birds).

(i) Where information was available at one capture but missing subsequently, the original information was assumed, where appropriate.

(ii) Certain codes not listed in the documentation were modified in the following way -

WEIGHT - codes of 9999 and 0 were both taken as "missing".

SEX - codes of 0, 6 and 9 were changed to "no sex" (ie.unknown). If the sex coding changed from banding to recapture or between recaptures, the most frequent code was adopted. If there were only two such recordings and they differed, the sex was regarded as unknown if not obtainable from other information.

AGE - if age changed from adult to younger in a subsequent recapture, the adult code was assumed.

MBAND - in the event of inconsistencies in the banding numbers, the mono band (MBAND) number was assumed to be correct and the titanium band (TBAND) changed accordingly.

Some 3000 plus records required manual modification to remove inconsistencies or to add relevant information.

New variables were created from the data in order to facilitate ready access of records from the file and to aid future analyses. They were

IDENT - a variable to distinguish whether or not a duck was recaptured subsequent to banding. A code of 0 was assigned to records of ducks with no subsequent recapture/recovery, 1 to the first record of a subsequently recaptured duck and 2 to the recapture/recovery records.

REP - the number of the record subsequent to the initial banding (repeats).

DAYBAND - the number of days since the initial banding. This is zero for initial records of ducks or for records of ducks recaptured on the same day.

In addition, for ease of tabulation and subsequent analyses, a file containing recodes has also been constructed. The recodes are given in the following table.

TABLE 1. RECODES

new code	old code	description
NSPEC	SPECIES	
1	1	Black Duck
2	2	Grey Teal
3	5	Aust Shelduck
0	rest	all other ducks combined
SEASON	MONTH	
1	12,1,2	summer
2	3,4,5	autumn
3	6,7,8	winter
4	9,10,11	spring
NAGE	AGE	
1	0	duckling
2	1-2	juvenile
3	3	sub-adult (mountain duck)
4	4-5	adult
0	6	unknown
NSEX	SEX	
1	1-4,7	male
2	5	female
0	0,6,9	unknown
NWEIGHT	WEIGHT	
1	1-8	0.01 - 0.25 Kg
2	9-17	0.26 - 0.50 Kg
3	18-26	0.51 - 0.75 Kg
4	27-35	0.76 - 1.00 Kg
5	36-44	1.01 - 1.25 Kg
6	45-52	1.26 - 1.50 Kg
7	53+	> 1.50 Kg
0	0,9999	unknown

TABLE 1 (Cont.)

new code	old code	description
NPLUM	PLUMAGE	
1	0	not in moult
2	1	body in moult
3	2	moulting - new primaries
4	3	moulting - new tail
5	4-8	down (ducklings)
0	9	unknown

After all corrections, additions and removal of duplications, the clean file now consists of 40,351 records on 33,114 ducks, 5,880 of whom have at least 1 recapture record. Of these, 4900 have one recapture, 717 have 2 recaptures, 187 have 3 recaptures, 51 have 4 recaptures, 18 have 5 recaptures, 1 has 6 recaptures, 3 have 7 recaptures, 2 have 8 recaptures, and 1 has 10 recaptures.

3. SUMMARY TABLES

The following tables summarize frequencies in the various categories for the main variables as they relate to the first capture only. Detailed analyses relating to recaptures and to changes of variables over time are not included here. Section 3.1 presents one-way tabulations, while selected cross-tabulations are given in §3.2. Other tables of frequencies, means etc. can be readily produced as required.

3.1 One-way frequency tables

Table 3.1.1. FREQUENCY TABLE FOR NAGE (age code)

age unknown	duck-ling	juven-ile	sub-adult (M.duck)	adult	TOTAL
9407	189	8159	21	15338	33114

Table 3.1.2. FREQUENCY TABLE FOR NSEX (sex code)

sex			
unstated	males	females	TOTAL
9433	13200	10481	33114

Table 3.1.3. FREQUENCY TABLE FOR NSPEC (species code)

Black duck	Grey teal	Mountain duck	Others	TOTAL
26149	5571	656	738	33114

Table 3.1.4. FREQUENCY TABLE FOR NWEIGHT (weight in kgs)

miss	≤0.25	≤0.50	≤0.75	≤1.00	≤1.25	≤1.50	>1.50	TOTAL
9607	72	3125	844	10766	8480	206	16	33114

Table 3.1.5. FREQUENCY TABLE FOR NPLUM (plumage code)

no info	not in moult	body in moult	new primaries	new tail	downy	TOTAL
9500	10307	2497	355	10402	53	33114

Table 3.1.6. FREQUENCY TABLE FOR OBTAIN (how obtained code)

trap & caged	no info	trap & release	net & release	snare & release	sight obs	trap & rel e/wh	caged & release	TOTAL
6	41	29171	3221	1	13	659	2	33114

Table 3.1.7. FREQUENCY TABLE FOR DD (day of first capture)

0	1	2	3	4	5	6	7	8	9
20	955	1244	1169	1154	1502	1163	1245	1194	1038

10	11	12	13	14	15	16	17	18	19
1446	1016	1317	1416	1039	1126	1402	894	903	834

20	21	22	23	24	25	26	27	28	29
1175	1098	815	1080	738	893	875	1241	1197	874

30	31	TOTAL
752	299	33114

Table 3.1.8. FREQUENCY TABLE FOR MM (month of first capture)

Jan	Feb	Mar	Apr	May	Jun	Sep	Oct	Nov	Dec	TOTAL
7018	5846	7501	4272	1210	81	53	208	1476	5449	33114

Table 3.1.9. FREQUENCY TABLE FOR YY (year of first capture)

1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
131	929	1038	301	1039	1052	1252	363	56	1032

1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1113	54	875	63	44	740	1133	1976	3557	3865

1972	1973	1974	1975	1976	TOTAL
4097	2696	2246	2690	772	33114

Table 3.1.10. FREQUENCY TABLE FOR SEASON (of first capture)

summer	autumn	winter	spring	TOTAL
18313	12983	81	1737	33114

Table 3.1.11. FREQUENCY TABLE FOR STATION (locality of banding)

Other/ miss*	Moora	Metro Area	Shenton Park	Woodan-illing	Alder-syde	Yanchep	Lara (Vic)
9386	8851	2849	2844	8909	156	102	15

Joanna (Vic)	L.Charm (Vic)	TOTAL
1	1	33114

*not recorded prior to 1967

3.2 Cross tabulated frequency tables

Table 3.2.1. FREQUENCY TABLE OF RECAPTURE BY SEX

	sex unstated	males	females	TOTAL
not rec	8176	10562	8496	27234
rec	1257	2638	1985	5880
TOTAL	9433	13200	10481	33114

Table 3.2.2. FREQUENCY TABLE OF RECAPTURE BY SPECIES

	Others	Black duck	Grey teal	Mountain duck	TOTAL
not rec	630	21552	4535	517	27234
rec	108	4597	1036	139	5880
TOTAL	738	26149	5571	656	33114

Table 3.2.3. FREQUENCY TABLE OF SEX BY SPECIES

	Others	Black duck	Grey teal	Mountain duck	TOTAL
sex miss	421	6538	2160	314	9433
males	147	11017	1902	134	13200
females	170	8594	1509	208	10481
TOTAL	738	26149	5571	656	33114

Table 3.2.4. FREQUENCY TABLE OF SPECIES BY WEIGHT

	Kg.							
	miss	≤0.25	≤0.50	≤0.75	≤1.00	≤1.25	≤1.50	>1.50	TOTAL
others	399	5	89	89	148	7	1	0	738
B.duck	6703	3	33	436	10523	8311	137	3	26149
G.teal	2190	64	3002	315	0	0	0	0	5571
M.duck	315	0	1	4	95	162	68	11	656
TOTAL	9607	72	3125	844	10766	8480	206	14	33114

Table 3.2.5. FREQUENCY TABLE OF SPECIES BY STATION

	Other/ u/k	Moora	Metro Area	Shenton Park	Woodan-illing	Alder-syde	Yanchep
others	393	300	23	4	18	0	0
B.duck	6531	5191	2826	2839	8652	8	102
G.teal	2147	3055	0	1	203	148	0
M.duck	315	305	0	0	36	0	0
TOTAL	9386	8851	2849	2844	8909	156	102

	Lara (Vic)	Joanna (Vic)	L.Charm (Vic)	TOTAL
others	0	0	0	738
B.duck	0	0	0	26149
G.teal	15	1	1	5571
M.duck	0	0	0	656
TOTAL	15	1	1	33114

Table 3.2.6. FREQUENCY TABLE OF SPECIES BY SEASON

	summer	autumn	winter	spring	TOTAL
others	311	301	2	124	738
B.duck	14078	11343	76	652	26149
G.teal	3579	1127	3	862	5571
M.duck	345	212	0	99	656
TOTAL	18313	12983	81	1737	33114

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Please address all enquiries to:

WESTERN AUSTRALIAN WILDLIFE
RESEARCH CENTRE
OCEAN REEF ROAD
WOODVALE
Phone (09) 405 1555

~~225~~ 34

Your Ref:
Our Ref:
Enquiries:

The Director
Australian National Parks
& Wildlife Service
PO Box 636
CANBERRA CITY ACT 2601

Postal Address
PO Box 51
WANNEROO W.A. 6065
Facsimile (09) 306 1641
Telex AA94616

ATTENTION: DR K. LOWE

Dear Sir

STATES ASSISTANCE PROGRAM 1986/87
PROJECT NO. 4460 - DUCK BANDING DATA ANALYSIS, STAGE 1

I am writing to give a brief summary of progress in the above project.

1) The Statistical Consulting Group, a self-funding unit in the Mathematics Department, University of Western Australia, has been appointed as a consultant. Prof. I.J. James and Mr D.A. Diepeveen are responsible for the statistical and computing parts, respectively, of the project.

2) We have just completed very thoroughly checking the data to eliminate all errors, mis-codings, etc, and Mr Diepeveen is preparing a report that documents all information in the data set.

3) Prof. James has been doing some preliminary work to decide which model for estimating annual survival, etc, is most suitable for our data.

4) I have obtained the available data about Grey Teal banded in Victoria but recovered in W.A. from the Arthur Rylah Institute to assist in the analysis of long-distance movements in this species. Through Dr Lowe, I am in the process of getting information on teal banded in the Northern Territory but recovered in W.A.

As soon as Mr Diepeveen's report is complete (about another fortnight) I shall forward a copy to Dr Lowe.

Yours faithfully

DR S.A. HALSE
SENIOR RESEARCH SCIENTIST

June 22, 1987

The University of Western Australia

Statistical Consulting Group

Department of Mathematics
Nedlands, WA 6009, Australia
Telegrams Uniwest Perth, Telex AA92992
Telephone (09) 380-3346

Your ref. Our ref.

31 March 1987

Dr. Stuart Halse
WA Wildlife Research Centre
PO Box 51
Wanneroo WA 6065

Dear Stuart

Thank you for your letter of March 25 regarding the offer of consultancy to the Statistical Consulting Group to analyse banded bird data.

The Consulting Group is happy to accept the consultancy under the conditions outlined, and we look forward to a fruitful collaborative effort.

We will copy the data onto magnetic tape as soon as possible, and contact you as soon as we have some preliminary analyses to discuss.

Sincerely

Ian James
Director

We discussed the types of analyses on 20th March. I envisage four avenues of investigation:

1. Estimating annual survival in Pacific Black Duck and Grey Teal (and we should probably look at the data for Australian Shelduck).

2. Looking at annual patterns of movement and the causes of specific movements. I hope to be able to get access to a number of records of birds (∿100-200) banded in the Northern Territory or Victoria and recovered in W.A. to beef-up our number of records for this analysis.

3. Trying to develop estimates of daily and seasonal hunting mortality for birds banded at Moora, and comparing this with estimates of total annual mortality for the Moora "population".

4. Descriptive statistics for various parameters, such as weight, that were measured during banding.

However, what is possible with the data will have to be determined as we proceed since I am not at all familiar with it. Also, you may be able to see other avenues that warrant investigation. Deciding on the plan of analysis needs to be very much a collaborative effort as, of course, does the whole project.

Yours sincerely

DR S.A. HALSE
Senior Research Scientist

March 25, 1987

Duck Banding consultancy for Andrew.

35

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31

Prof. Ian James
Statistical Consulting Group
Department of Mathematics
University of Western Australia
NEDLANDS 6009

4 pm → Maths Dept
Rm 135
first floor
south-eastern corner

Dear Ian

Thank you for the information in your letter of 23rd March; it certainly satisfied our requirements. I would like to offer the Statistical Consulting Group a consultancy to analyse our duck-banding data under the following conditions:

1. The Department will make an initial payment of $6,000 to the Consulting Group in mid-April and subsequent payments of $6,000 in July and October. A final payment of $6,000 will be made on receipt of the final report.

2. Because the Department must make its final payment by April 1988 the project must be completed by that time. However, it would be desirable to finish the project within nine months, ie by the end of 1987.

3. The Department has no desire to spend the full $24,000 unless necessary. If the analysis is completed quickly and easily, it may be appropriate to change the payment schedule so that the Department retains some of the money.

The data to be analysed consists of a very large number of records of birds banded, recaptured alive in subsequent banding or recovered dead. All this is on magnetic tape and we are arranging to have it accessible on the University's computers at the beginning of April. In addition, there are ~150 records of birds recaptured or recovered that are not in the computer data set and will need to be entered. I can give you this data, together with information on the coding systems used and general background to the study sites etc., when you are ready to begin transferring data.

../2

People connected with large scale projects in which we have been involved whom you may wish to contact include

Mr Peter Clarkson, Chief Water Engineer
Metropolitan Water Authority

Mr George Gallen, State Energy Commission of WA

Dr Dallas English, NH&MRC Unit in Epidemiology and Preventive Medicine, QE II Medical Centre

Mr John Whitehand, Argyle Diamond Sales Ltd

If any of the other reports on our list are of interest to you we would be happy, subject to client approval, to provide copies.

I hope the enclosed information is adequate for your purposes, and that we will be able to collaborate with you on your very interesting project. Please get in touch if you have further queries.

Yours sincerely

Ian R. James
Director

Stuart

I suggest contacting a couple of the above to confirm their satisfaction with the SCG.

Then an colleague of letters with SCG to cover terms and conditions of the proposed consultancy. (I am not sure whether our intention is to use SCG rather than appoint an officer to use SCG. Suggest here needs to be cleared by SOITR. Suggest have a look at the file and let me know if you think it does)

You might also consider committing say $22,000 of the $24,000 and holding the balance in reserve. This might reduce the possibility of a cost over run.

20/3

20/3/87
No, checked with Erica ← never a we can proceed but agreed should let applicants know we will use SCG

The University of Western Australia

Statistical Consulting Group

Department of Mathematics
Nedlands, WA 6009, Australia
Telegrams Uniwest Perth, Telex AA92992
Telephone (09) 380-3346

Your ref. Our ref.

23 March 1987

Mr Stuart Halse
Wildlife Research Centre
PO Box 51
Wanneroo WA 6065

Dear Stuart

As requested at our meeting at the Wildlife Research Centre last Friday I enclose further documents and reports relating to the operation of the Statistical Consulting Group.

Included is a list of consulting reports written since 1982, with a few sensitive titles omitted. Please treat the list confidentially. I hope this list will give some idea of the broad range of projects undertaken by the Group.

Also included are some non-confidential reports and the summary publication resulting from a large domestic water use study, for which we provided nearly all of the estimation and statistical input. The detailed working papers (two volumes of about 400 pages) are due to be released shortly. These studies are of course quite different from yours, but they indicate that the Group has the expertise and flexibility to successfully and innovatively carry out large-scale projects on a variety of topics. (We have a limited number of copies of the DWUS report and would appreciate its return in due course).

I am confident that we have the expertise and experience within our ranks to obtain the maximum information from your data; much of the capture - recapture methodology is familiar to us through teaching and reading of the literature, and several of us have considerable expertise in various aspects of survival analysis. I am currently conducting joint research on a version of capture - recapture survival for tagged fish, which is slightly simpler than your situation but of a similar ilk. There, for each of n animals one has "survival times" $s_1, \ldots, s_n$ and "recapture times" $t_1, \ldots, t_n$ and one observes the t's for those animals recaptured before death. In your study one has the extra information of "death times" for the ducks shot. This extra information can be easily incorporated.

The University of Western Australia

DEPARTMENT OF MATHEMATICS STATISTICAL CONSULTING GROUP

Personnel

Board of Management:

Dr. M.T. Partis, Head, Department of Mathematics
Associate Professor I.R. James, Director
Professor T.C. Brown, Professor of Statistics, UWA
Dr. R.K. Milne, Senior Lecturer in Mathematics, UWA

Full-time Consulting Group Members:

Associate Professor I.R. James
Mr. P.E.B. Fitzgerald
Mr. D. Diepeveen

Academic Staff Member Associates (all of whom contribute on a part-time basis)

Professor T.C. Brown *(applied statistics, stochastic processes, probability, spatial processes)*
Dr. R.K. Milne, Senior Lecturer *(applied statistics, point processes, applied probability)*
Associate Professor A.G. Pakes *(probability theory)*
Dr. M.L. Thornett, Lecturer *(design and analysis of experiments, sampling theory)*
Dr. K. Vijayan, Senior Lecturer *(sampling theory, multivariate analysis, design and analysis of experiments, combinatorics)*
Dr. L. Jennings, Senior Lecturer *(computing, numerical analysis, optimisation)*
Dr. M. Knuiman, Lecturer (from July 1987) *(medical statistics, categorical data analysis, applied statistics)*
Dr. T.J. Dickson, Part time Senior Lecturer *(operations research, network theory, optimisation)*

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The University of Western Australia

DEPARTMENT OF MATHEMATICS STATISTICAL CONSULTING GROUP

Members -- Qualifications and brief biographical notes

Ian R. James - Director

BSc (Hons) Flinders University of South Australia 1969
PhD in Statistics, Flinders University 1973

Research Scientist, CSIRO Division of Mathematics and Statistics, in Adelaide (1973 - 75) and Melbourne (1975 - 78), carrying out fundamental research and consulting with other CSIRO Divisions and outside organizations. Main consultant to Division of Chemical Technology.

Lecturer (1978 - 82), Senior Lecturer (1983 - 86) and Associate Professor (1987 -), Department of Mathematics, University of Western Australia. Visiting Associate Professor, Department of Biostatistics, University of Washington (1985)

Member, Department of Mathematics Consulting Group (1978 - 87), Director (1983-84). Director, Statistical Consulting Group (1987 -). Extensive consulting experience in a wide range of areas.

Research interests and publications in various areas of statistics, including survival analysis, censored data, random proportions, mixtures, sampling, surveys and observer agreement.

President of the WA Branch of the Statistical Society of Australia.

Dean A. Diepeveen

BSc Hons (Ag) (Biometrics) University of Western Australia (1983)

Research Assistant, Raine Medical Statistics Unit 1984.
Research Assistant, Statistical Consulting Group 1985 -

Major research projects include analyses of SEC peak load data, diabetic survey data, and multiple sclerosis data.

Particular expertise in computing and large scale file manipulation, statistical computer packages and biometrics.

Pat E.B. Fitzgerald

B App Sc (Mathematics and Computing Science), WAIT (now Curtin University) 1983.

Tutor at WAIT 1984 and part 1985.
Research Assistant, Statistical Consulting Group mid 1985 - .

Has been responsible for major projects in medical statistics, large scale SEC data analyses relating to prediction of peak consumption figures and a variety of smaller projects.

Research interests include the analysis of ordered categorical data, applied statistics generally and statistical computing.

Secretary, WA Branch of The Statistical Society of Australia.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Form C.L.M. 808 204

WILDLIFE RESEARCH CENTRE Office,

To STUART HALSE February 5 19 87

Western Australia

Reference-H.O.

Local

SUBJECT: ANALYSIS OF DUCK BANDING RECORDS.
~~STATES ASSTSTANCE GRANT TO CALM.~~

Following our discussion this morning it would seem to be useful for me to put on paper a few aspects about the running of this project, in order to minimize uncertainties.

Thank you for drawing to my attention the fact that in requesting you to prepare a proposal for consideration under the Commonwealth Government's State's Assistance Program I indicated that you should be "supervisor" of the project should funds be forthcoming.

I do indeed intend that you should take on this role however as Research Centre Manager and as Program Leader I have certain administrative and other responsibilities. Perhaps I have been remiss in not indicating more clearly what these are.

My first concern has been to ensure that CALM does not take on an inadequately funded project. It is for this reason that I sought your advice on likely costs and subsequently advised ANPWS that CALM would not accept the project at less than $24 000. As you know ANPWS subsequently shifted its position from a maximum of $20 000 to the $24 000 CALM requires. This will be provided as $6 000 in 1986/87 and $18 000 in the following year.

My second responsibility as Program Leader is to see that CALM employs the best person available to do the job. I therefore wish to see the position advertized, preferably nationally. The selection is to be made by a panel of four persons - yourself as project supervisor, a statistician (Dave Ward?), Mike Choo to cover computing requirements, and myself as Program Leader.

Responsibility for supervision and guidance, for ensuring that funds are correctly spent and for ensuring that the project does not run over budget is yours as project supervisor. I would of course be pleased to contribute to discussions on scientific aspects of the project.

Funding for the project was confirmed on Monday by Telex. I presume you would like to make a start as soon as possible in order that the $6 000 allocation for 86/87 may be spent this financial year. Please proceed.

J. LANE
PRINCIPAL RESEARCH SCIENTIST

40593/5/85—50M—MS/3998

16 274

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AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE

HEAD OFFICE
G.P.O. Box 636
Canberra, A.C.T. 2601
Construction House
217 Northbourne Avenue
Turner A.C.T. 2601
Phone (062) 46 6211
Telex AA62971

DARWIN OFFICE
P.O. Box 1260
Darwin, N.T. 5794
Ground Floor, Commercial Union Building,
Smith Street, Darwin, N.T. 5794
Phone (089) 81 5299
Telex AA85130

Our ref: 120/7/18
Your ref: GS:TW

Mem 6018

24 February 1987

Dr. S. Shea
Executive Director
Department of Conservation
and Land Management
P.O. Box 104
COMO W.A. 6152

Attention: Mr. K. McNamara

Dear Dr. Shea,

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1986/87
Provision of Funding for Three Additional Projects

I refer to your telex of 16 January and 3 February 1987 confirming your Department's acceptance of the ANPWS offer of funding assistance for three additional projects.

Please find enclosed a cheque for $21,000 as the ANPWS financial contribution to the three projects for 1986/87. That sum comprises:

	$
Boodie Island Management	3,000
Endangered Eucalypt Survey	12,000
Duck Banding Data Analysis	6,000
	$21,000

copy on project file 17/3/87

Also enclosed are the Specifications for each project and the General Conditions relating to all projects conducted under the States Co-operative Assistance Program.

As indicated in the Specifications, a further $18,000 has been set aside for the Duck Banding Data Analysis Project in 1987/88, subject to satisfactory progress.

The ANPWS Project Officers for the three projects are: Dr. Gerry Maynes (Boodie Island), Dr. Jane Mowatt (Endangered Eucalypts) and Dr. Kim Lowe (Duck Banding). They have been asked to liaise with the relevant officers of your Department as the projects progress.

Yours sincerely

Cashier
Record receipt No + file correspondence

Professor J. D. Ovington
Director

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ATTACHMENT 1
120/7/18

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1986/87
CO-OPERATIVE PROGRAM BETWEEN THE AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE (ANPWS) AND THE WESTERN AUSTRALIAN DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT (WADCALM)

GENERAL CONDITIONS
RELATING TO EACH PROJECT CONDUCTED UNDER THE PROGRAM

1. Unless otherwise agreed in writing by the Director ANPWS, each project is to be completed by 30 June 1987. ANPWS is to be advised by 1 June 1987 if any of the funds provided by ANPWS in 1986/87 will not be utilised and reimbursement to ANPWS of those unutilised funds must be made by 20 June 1987. A written acquittal that all funds have been expended in accordance with the project specification must be forwarded to ANPWS by 7 July 1987.

2. The assistance is provided on the understanding that involved parties may each use the results of the project and any related material for purposes connected with their respective statutory functions. Any publications resulting from the project must acknowledge the assistance given by ANPWS.

3. ANPWS is to be provided with six copies of any report, plan of management or other written document produced as part of a project.

4. Staff are to be engaged by WADCALM and shall not thereby become in the service or employment of the Commonwealth. WADCALM shall be responsible for effecting all insurances required under Worker's Compensation legislation and for taking all other such action requisite as employer in relation to WADCALM employees engaged in the project.

5. WADCALM and its employees and agents shall indemnify and keep indemnified the Commonwealth from and against any claim, demand, action, suit or proceeding that may be made or brought by any person against the Commonwealth or the employees or agents of the Commonwealth or any of them in respect of personal injury to or the death of any person whatsoever or loss of or damage to any property or any other loss or damage whatsoever arising out of or as a consequence of an unlawful act or a negligent act or omission by WADCALM or its employees or agents in the course of carrying out the project and also from any costs and expenses that may be incurred with any such claim, demand, action, suit or proceeding.

ATTACHMENT 4
120/7/18

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1986/87
CO-OPERATIVE PROGRAM BETWEEN THE AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE (ANPWS) AND THE WESTERN AUSTRALIAN DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT (WADCALM)

PROJECT SPECIFICATIONS

PROJECT NO: 4460.

PROJECT TITLE: Duck Banding Data Analysis, Stage 1.

PROJECT OUTLINE:

. Commence a study, designed to last nine months, involving:

- analysis of banding and recovery data from ducks banded by WA Fisheries and Wildlife Dept;
- use of data on sex, age, weight and moult to elucidate movements, survival rates, seasonal weight changes and moulting activity of the banded ducks.
- an attempt to assess hunting mortality from these data;
- a final report including details and results of analyses; and
- supply of banding, recovery and measurement data to the Australian Bird Banding Scheme in appropriate format.

. Submit before 30 June 1987 a brief progress report, for assessment in relation to further funding in 1987/88.

PROJECT DURATION: To 30 June 1987 (Stage 1).

PROJECT SUPERVISOR: Mr Jim Lane (WADCALM), Wanneroo, (09) 405 1555.

PROJECT OFFICERS:
WADCALM - To be determined.
ANPWS - Dr Kim Lowe, Canberra, (062) 46 6304.

AGENCY INPUTS 1986/87:
ANPWS - $6,000 (with a further $18,000 set aside for 1987-88 dependent on progress achieved).
WADCALM - Project supervision; computerised banding data; technical & administrative support.

[Compiled: February 1987]

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022096F2112

GA
62971
ANPWS AA62971
LANMAN AA94585

TO: PROFESSOR J.D. OVINGTON, DIRECTOR, ANPWS

THANK YOU FOR YOUR TELEX OF 2/2/87 OFFERING $24,000 FOR DUCK-BANDING DATA ANALYSIS PROJECT. THE GENERAL CONDITIONS ARE ACCEPTABLE AND YOUR OFFER IS GRATEFULLY ACCEPTED. OUR CONTACT OFFICER IS JIM LANE ON (09) 405 1555.

SYD SHEA
EXECUTIVE DIRECTOR, DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

3/2/87

*
ANPWS AA62971
LANMAN AA94585
=
-D=01:40-S:38A-H:08A47.....

1/ RECORDS
Plse file (old number W.650/84).
11.02.87

2/ Roger ~~Underwood~~
Further to my recent note to you, funding for this project came through subsequently & somewhat unexpectedly
K.M.O.
3/2/87

Noted, good.
13/2

3/ Alex ~~Errington~~ 4 A/Accountant
fyi.

(note: copy has been sent to Andrew Burbidge & Jim Lane)

11
+97

258

*
LANMAN AA94585
ANPWS AA62971

2 FEBRUARY 1987

TO: DR. S. SHEA
EXECUTIVE DIRECTOR W.A. CALM

FROM: PROFESSOR J. D. OVINGTON
DIRECTOR ANPWS

ATTENTION: K. ~~MCNAMARA~~ KMcN. 2/2/87

RE: STATES CO-OPERATIVE ASSISTANCE PROGRAM 1986-87

1. ANPWS CAN OFFER $24,000 FOR THE DUCK BANDING DATA ANALYSIS PROJECT IN TWO PAYMENTS - $6,000 IN 1986-87 AND $18,000 IN 1987/88.

2. THIS OFFER IS SUBJECT TO YOUR ACCEPTANCE OF GENERAL CONDITIONS IDENTICAL TO THOSE APPLYING TO EXISTING PROJECTS.

3. PLEASE ADVISE ASAP YOUR RESPONSE TO THIS OFFER AND NOMINATE CONTACT OFFICER SO THAT DETAILS CAN BE ARRANGED.

MESSAGE ENDS

*
LANMAN AA94585
ANPWS AA62971
=
-D=02:09-R:34A-H:06A30.....

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Jim,

1) I originally asked for

Salary	18 000
Computing	8 000
	26 000

The computing cost assumed the project would run from Oct 1986 to June 1987 and that we would use the UWA Cyber at an approx cost of $1 000 pa month

2) The computer situation has changed. Supposedly the Dept will have a Vax of its own from July 1987 onwards and we will use this at no cost. However, there may be delays in installation (and the project may start earlier as well). In the interim period before the Dept Vax is operational we will use the Lissc Vax, for which we believe (Morgan & Choo) there will be no charge to individual projects since the Dept pays a fixed rental charge for <u>all</u> Dept use.

3) With this scenario, the computing costs can be reduced to $ 2000 to cover the remaining verification of data (only a very small section remains to be checked) and transfer from the Cyber to the Vax, plus incidentals.

<u>ie</u> I am now asking for

Salary	18 000
Computing	2 000
	20 000

4) However, there is a problem with use of the Lissc Vax if the Dept computer is much delayed. It is <u>possible</u> that Lissc will charge individual projects next financial year, in which case we will need

almost $1000 per month extra until the Dept computer is functional, ie we could want about another $4 000.

An additional problem is the Lisse do not like large data sets, which was the reason for initially proposing to use the UWA Cyber (where the data currently resides - Norm Hall used the Cyber). This should not be a problem with the Dept Vax.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

HEAD OFFICE
HACKETT DRIVE CRAWLEY
WESTERN AUSTRALIA
Phone (09) 3868811
Telex AA94585
Facsimile (09) 3861578

STATE OPERATIONS HEADQUARTERS
50 HAYMAN ROAD COMO
WESTERN AUSTRALIA
Phone (09) 3676333
Telex AA94616
Facsimile (09) 3671430

Please address all correspondence to Executive Director, P.O. Box 104, COMO W.A. 6152

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203
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Your Ref:
Our Ref: W.650/84 KM:sp
Enquiries: K McNAMARA

Professor J D Ovington
Director
Australian National Parks and
Wildlife Service
GPO Box 636
CANBERRA ACT 2601

Dear Professor Ovington

STATES CO-OPERATIVE ASSISTANCE PROGRAM 1986/87

Thank you for your letter of 12 March 1986 (your ref. 120/8/08) inviting proposals for the abovementioned Program in 1986/87. The continuing support for this program is greatly appreciated as it has been of considerable assistance to nature conservation in this State and nationally.

I believe that Western Australia provides the opportunity for many nature conservation projects of national and international significance. The State covers one-third of Australia's land area and, on 1984 figures (ANPWS Occasional Paper 10), contains 46% of Australia's parks and reserves. The coastline is 12,500 km long, or one-third of the national total, giving the State a significant responsibility for conservation of marine environments. Other special features of Western Australia include its high proportion of nationally endangered plants and animals, and its 3,400 offshore islands many of which are very important for nature conservation. Two areas in the State are Biosphere Reserves and other areas are important habitat for birds listed under the Japan-Australia Migratory Birds Agreement. In addition, consideration is being given within the State to areas which might be proposed for inclusion on the World Heritage list and the List of Wetlands of International Importance.

A real problem in addressing these and other nature conservation responsibilities is the relatively small taxpayer base in Western Australia. I should also point out that opportunities for projects involving interstate co-operation, in which you express particular interest, are somewhat more limited than may be the case elsewhere.

As requested in your letter, I submit the projects listed below for your consideration. In each case a contact officer is named and the amount requested in 1986/87 is given. For some new projects, identified below, the 1986/87 financial year cost would be less than the amount shown if the project could not be started until about January 1987. You will note from the comments below that some projects might be more suited to the Research and Surveys Program and I would be grateful if you would consider them under that Program if you believe it appropriate.

Continuing Projects

1. Conservation of two kangaroo-paw species (Dr S Hopper, ph: 405 1555)

   $26 000

2. Hamersley Range National Park plan of management (Dr A Start, ph: 091 868 258)

   $20 000

3. Ningaloo Marine Park research program (Dr B Wilson, ph: 386 8811)

   a) Fish stock assessment $12 000
   b) Physical Oceanography $15 000

New Projects (In Department's priority order)

4. WA marine turtles (Dr R Prince, ph: 405 1555)
   (Builds upon earlier States Assistance Program support for work on dugongs with West Kimberley Aboriginal communities)

   $16 500

5. Rat eradication on Boodie I. (Mr K Morris, ph: 091 868290)

   (Part of an ongoing program of feral animal eradication on north-west island nature reserves, which has previously been supported through the States Assistance Program. Note that work is proposed on Middle I. in 1987/88. Attention is also drawn in the proposal to the need for work on the Monte Bello Islands which are likely to revert from Commonwealth to State control)

   $ 3 000

6. Fox control research - development of effective and economic fox control methods for the conservation of endangered marsupial species (Dr J Kinnear, ph: 405 1555)

   (May be suitable for consideration under the Research and Surveys Program and has been discussed with ANPWS officers in that context)

   $37 200

7. Rare WA eucalypt survey (Dr S Hopper, ph: 405 1555)

   $16 225

8. Collation and review of data relevant to fire in the Kimberley Region (Mr P Kimber, ph: 367 6333)

   (May be suitable for consideration under the Research and Surveys Program. Total funding sought ie. $21 800, could be spread across two financial years, eg publication would not be until 1987/88)

   $21 800

9. Biological survey of the Eastern Group, Recherche Archipelago (Mr A Hopkins, ph: 405 1555)

   (Project involves participation of SANPWS and Australian Heritage Commission staff)

   $ 4 000

10. Preliminary assessment of mallee-fowl in south-western Australia (Mr A Hopkins, ph: 405 1555)

    (Builds upon earlier States Assistance Program support for work on mallee-fowl in the eastern States and involves participation of NSWNPWS staff)

    $ 4 000

11. Analysis of duck-banding data from WA (Dr S Halse, ph: 405 1555)

    (May be suitable for consideration under the Research and Surveys Program, or as part of the Australian Bird Banding Scheme. Total funding sought, ie. $26 000, could be spread across two financial years. Will assist in the identification of important wetlands)

    $26 000

Additional detail is provided in the outlines attached for each project.

In addition to the above projects for which funding is sought, there are several other existing and potential co-operative projects which should be mentioned:

(i) The Aboriginal ranger training scheme is progressing well and is not dealt with further here;

(ii) Planning for an aerial survey of kangaroos (& emus) in WA in 1987 by the Kangaroo Monitoring Unit is proceeding satisfactorily. This Department is seeking funds in its Budget to allow cost-sharing, on an equal basis, of the $44 000 cost identified in your letter of 17 February, 1986 (your reference 290/2/10 MF/MR);

(iii) At a suitable time this Department might again wish to discuss the short-term loan of an ANPWS officer to assist with national park interpretation;

(iv) Officer-level discussions have commenced in relation to possible work on rare and endangered macropods in WA involving assistance from the Kangaroo Monitoring Unit;

(v) Following officer-level discussions on the ANPWS Index of Ecosystems Program, this Department's Principal Wildlife Research Officer wrote to you on 24 April, 1986 enclosing an application for consultancy funds to support the proposed biological survey of the Shark Bay region;

(vi) There will need to be further discussions concerning the declaration and management of Ningaloo Marine Park;

(vii) The Government has recently announced that it will declare a national park in the Bungle Bungle area. You will recall that the House of Representatives Standing Committee on Environment and Conservation has reported on the protection of this area.

This Department's contact officer for the Program is Mr K McNamara (ph: 09 386 8811).

Yours sincerely

Syd Shea
EXECUTIVE DIRECTOR

5 May 1986

PROJECT: ANALYSIS OF DUCK-BANDING DATA FROM WESTERN AUSTRALIA

Scope and end-product: Between 1952-65 and 1968-74 the Fisheries & Wildlife Department banded 33961 ducks, mostly Pacific Black Duck and Grey Teal, at various locations in south-western Australia. Data on species, sex, age, weight and moult stage were collected and, together with information on recaptures and band recoveries, were stored on computer. A total of 4242 birds were retrapped at least once and 2880 bands were returned from dead birds in both Western Australia and the Eastern States.

It is proposed to employ a research officer for nine months to analyse the data with the objective of gaining information about movements, survival rates, seasonal weight changes and moulting. Some of the data are suitable for estimating daily hunting mortality.

Justification: Ducks, particularly Grey Teal, move widely around Australia so there is a need to gather sufficient information about seasonal movements, population sizes, and shooting mortality to plan for duck management on a national level. The RAOU program in Western Australia, funded by the Department of Conservation and Land Management, is providing data on population sizes; the proposed analysis will give information about seasonal movements and mortality.

The identification and future management of important wetlands will require better knowledge of duck movements and population dynamics than currently exists.

Duration: 1 October 1986 to 30 June 1987.

Officer responsible for project: Dr S A Halse.
(09) 405 1555

Source of personnel: Temporary research officer

Budget:		
	Salary	$18 000
	Computing costs	8 000
	Total requested	$26 000

Non-financial contribution: The Department of Conservation and Land Management will provide the computerized banding data, technical assistance with computing problems and administrative back-up. On completion of analysis, the Department would be happy to give the data to the Australian Bird Banding Scheme, if so desired.